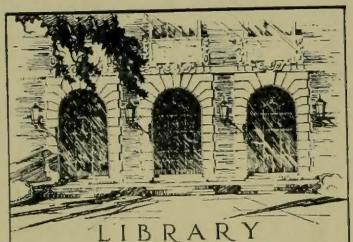

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Proceedings

of the

First Annual Convention

of the

American Railway Engineering and Maintenance-of-Way Association

held at

Steinway Hall, Chicago, Illinois
March 14 and 15, 1900

Containing also the Constitution, List of Charter Members, List of Officers for 1900, Standing Committees and Outline of Committee-Work, Mileage of Railroads Represented in the Association, Circulars Issued to Date, Etc.

Published by the Association
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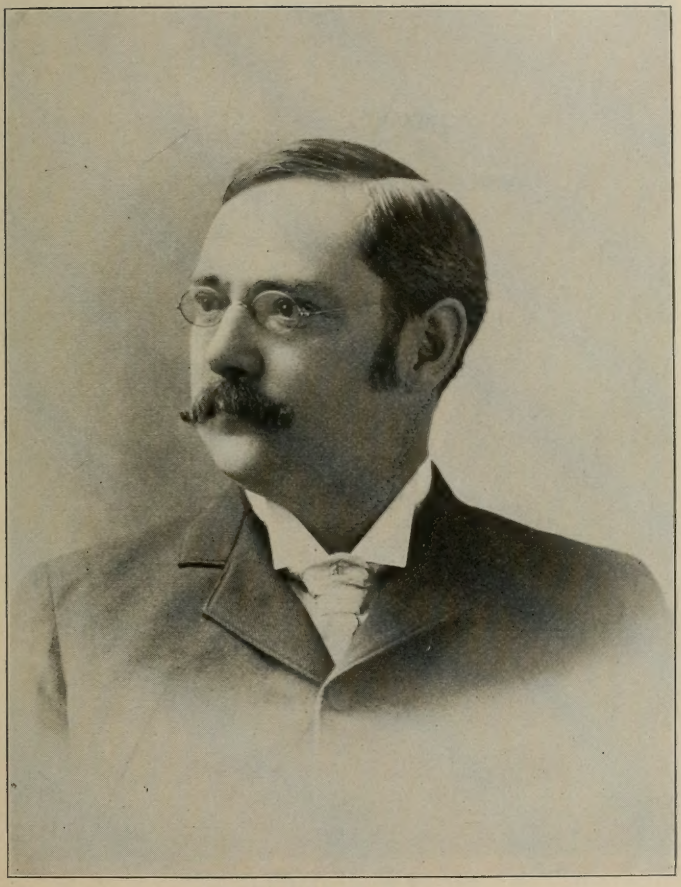
1900



J. F. WALLACE, PRESIDENT.

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L. C. FRITCH, Secretary

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PROCEEDINGS

OF THE

FIRST ANNUAL CONVENTION

OF THE

American Railway Engineering and Maintenance-of-Way Association.

The meeting was called to order at 10:30 a. m. by the President, Mr. J. F. Wallace.

"Gentlemen:—I am much pleased to have the honor to call to order the First Annual Meeting of the American Railway Engineering and Maintenance-of-Way Association, and you will therefore pardon my embarrassment. This hall is very difficult to speak in, particularly for the class of men that are in it to-day, and I hope you will all be as quiet as possible, and that during the actual speaking, either of the chairmen or of the various committeemen, that there will be no going-in or going-out, as the intervals between the different reports will give opportunity for that purpose.

"Before we open up formally and commence the regular order of the meeting, I wish to announce that the Atchison, Topeka & Santa Fe Railway, through the kindness of Mr. J. M. Barr, has tendered us a train that will leave the Dearborn-Street Station this afternoon at 2:30, to take us on a trip to Joliet and show us the Drainage Canal and the Controlling Works at that point, and the various other industries at Joliet, including the rail-rolling process, and that lunch will be served upon that train immediately upon leaving the station, so that if you are detained here with

our work, you may all know that you can get luncheon on the train. If any of you have your ladies with you, and desire to take them with you upon that excursion, you may do so and will be welcome.

"One peculiarity about our Constitution that I notice in looking over the order of procedure, is that the President of the Association is required to deliver an address at this time, and the Constitution also implies that the members are required to listen to it, although that is not stated in so many words.

"On account of the embarrassment that one naturally feels in meeting you all for the first time, I have written this out and propose to read it, if you will kindly pardon me. Instead of reading the minutes of the last annual meeting, I have embodied in this paper a concise history of our Association up to date."

PRESIDENT'S ADDRESS.

"At this, the First Annual Meeting, it would seem proper to state in a general way the problem that is before us for solution, to give an outline of progress to date, and to suggest the general lines upon which our future work should be carried out.

"In October, 1897, a circular letter was addressed to railway officials in the United States, inviting an expression of opinion on the subject of the organization of an association of railway officials interested in or connected with the engineering and maintenance-of-way departments of American railroads. Over one hundred favorable replies were received, approving the movement, and expressing a desire to be identified with the organization.

"In September, 1898, a call was issued for a preliminary meeting, to be held in Chicago during October of that year. This meeting was held October 21, 1898, at the Auditorium Hotel in Chicago, about twenty railroad officials being present.

"Mr. H. P. Robinson, of 'The Railway Age,' called the meeting to order, explained its purpose, and submitted valuable data as a basis for organization. Mr. A. Torrey, Chief Engineer of the Michigan Central Railroad, was chosen Chairman, and Mr. L. C. Fritch, Superintendent of the Baltimore & Ohio Southwestern Railroad, Washington, Ind., Secretary. A committee appointed by the Chairman recommended that the organization be called 'The American Railway Engineering and Main-

tenance-of-Way Association,' and this name was adopted. The Chairman also appointed a committee consisting of five representative maintenance-of-way officials to draft a constitution and by-laws, and to report at the next meeting.

"At the meeting to effect a permanent organization, held in Buffalo, March 30, 1899, this Committee reported a draft of constitution which was unanimously adopted. At that meeting permanent officers were elected and the organization perfected.

"During the past year the officers and Board of Directors have held numerous meetings, selected the chairmen, vice-chairmen and members of the various committees, and revised and perfected the outline of committee-work. This has entailed a large amount of labor, which can hardly be appreciated by anyone not familiar with the actual details of what was accomplished. Great care has been taken in the appointment of these committees. How far this effort has been successful, the future results of the work of the Association will demonstrate.

"The object of the Association, as stated in the Constitution, is the advancement of knowledge pertaining to the scientific and economical location, construction, operation, and maintenance of railroads.

"The present railroad mileage in the United States, Canada and Mexico is approximately 216,714 miles, owned by 2,200 different corporations. Many of these lines, however, while having distinct legal existence, are either owned, controlled, or operated by other corporations. The number of accounting corporations is approximately 1,100, and the number of actual independent operating corporations 850. The railroad properties are capitalized at approximately ten billion dollars, 54 per cent of which is represented by stock—common and preferred—and 46 per cent by bonds. Of the common stock, 66 per cent does not receive dividends, and 16 per cent of the bonds pay no interest. The average rate of dividend on those roads paying any return on their stock is 5.3 per cent—that is, 34 per cent of the railroad stock of the United States, Canada and Mexico pays 5.3 per cent annually on the investment. The valuation of all railroad properties on a 5-per-cent dividend basis would be, in round numbers, seven billion dollars.

"The amount expended on maintenance and structures of all these roads during the fiscal year ending June 30, 1898, was

estimated at $188,000,000. Owing to the more prosperous times, these expenditures have been rapidly increasing, until at the present time they are placed at $200,000,000 annually. It is also estimated that $180,000,000 per annum is being expended in improvements and extensions, provided for out of increased capitalization and not charged to maintenance; this sum covering the construction of new lines, reduction of grades on existing lines, additional tracks, terminal facilities and general improvements to the properties. During 1899 there were 5,493 miles of new railroad added to the total mileage.

"Approximately, 20 per cent of the total expense of operation of all the railroads is due to maintenance-of-way and structures. According to the last official reports, there were 288,000 employes in the engineering and maintenance-of-way departments, at a total compensation of about one hundred million dollars per annum. At the present time this number is no doubt much larger.

"The above figures are, of course, more or less approximations, as part of the data was obtained from official reports one or two years old, these being supplemented by rough estimates to bring the figures down to date. They are certainly conservative, however, and sufficiently accurate to at least lay before you the magnitude of the problem we have to face and to indicate the importance of the work which this Association and the individual members thereof have before us, in the economical maintenance of these important properties. To this end our Association has been formed, and it is desired to bring into it not only civil, mechanical and electrical engineers, whose general professional training may fit them for working out the solution of the technical part of the problem, but also, as stated in the Constitution, all classes of railroad officials having supervision of maintenance-of-way matters, from general managers down to engineers of maintenance-of-way in charge of divisions, or other railroad men bearing other titles but performing similar duties. The term general manager in this clause of the Constitution is used in the larger sense, and is intended to embrace presidents, vice-presidents or other officials interested in the general management of railroad properties.

"You will note that our membership is intended to include two elements—the technical and the practical—and it is hoped

and expected that the intercouse between the technical engineer and the practical railroad man will be of mutual benefit, that the technical man will become more practical and the practical man more technical, through the interchange of ideas and information which this Association is designed to foster.

"It is unnecessary for me to say that this Association fills a long-felt want, and that it has a broad field to develop. If the work is industriously and systematically carried forward it will gradually assist us all in attaining the end sought for.

"It has been the custom of engineering and maintenance-of-way associations heretofore to carry on their work without that system and continuity of purpose which is the only true means of successfully accomplishing the desired results. The work of our Association has been laid out on unique lines. It is the intention to cover the entire field of engineering and maintenance-of-way research, divide up the subjects in systematic order, and continue and increase our standing committees and the subjects under consideration from time to time in order to do so. While a little later on we expect to hear from the chairmen of the fourteen standing committees as to their ideas of the purpose and methods of their committee-work, I would like to state in a general way that it was not the intention, nor is it possible for any of these committees to exhaust the subject-matter given them for consideration in a single year, or even within the lifetime of the individual members. The first work of each committee should be the collection of facts, which should be properly compiled, condensed and abstracted for the information of the Association at large. As the facts are obtained under the different heads or subheads, reports can, of course, be made from time to time by the different committees on these subjects which have been considered.

"But while the committees may increase their membership and subdivide the subject-matters under consideration, assigning different detail subjects to individual members, they should not overlook the necessity and importance of working as a unit and fully comparing and discussing results in committee meetings. When they come before this Association as a body they should come as a unit and act together, and it is expected that they will be prepared to answer all questions that may be asked

by members of the Association in regular meetings, and explain or defend the positions taken by the committee.

"Our progress from the inception of this movement must certainly be gratifying to the members of the Association, but they should not fail to remember that while during this first year of the organization the burden of work has been borne by the officers and directors, from now on the measure of success of our Association depends largely, if not entirely, on the efforts of the individual members.

"We should not forget that we are the servants of the investors in railway securities, and that it is our duty to endeavor to secure the largest possible return on the capital invested. It is the function of the railway to furnish transportation to the public with the maximum amount of speed and safety to person and property, the greatest convenience to its patrons, and at minimum cost. We should have it in mind that the highest economy in the location, construction, maintenance and operation can only be obtained when the interest on cost of construction, plus the expense of maintenance and operation, are kept down to the minimum. It is not economy to so locate and construct a line of railroad that, while the expense of operation and maintenance will be very low, the saving will be more than counterbalanced by the excessive fixed charges due to the original outlay. On the other hand, it is not economy to locate and construct your road so cheaply that while the fixed charges may be comparatively light, the cost of operation and maintenance will be excessive. This principle applies not only to original location and construction of a railroad, but to all the improvements and additions which may seem necessary or desirable after the line has been placed in operation.

"For instance, it may be economy on some roads to make large expenditures in the reduction of grades, if this expenditure will result in a saving in operating expenses in excess of the fixed charges due to the investment. It is economy to construct water tanks of large capacity, if by so doing the service of night pumpers can be done away with and a sufficient amount saved on operating expenses to justify the outlay. It is economy to provide passing tracks if such are necessary in order to facilitate train movements, thereby reducing the length of time consumed by trains on the road or rendering the train service more efficient.

It is also economy to make numerous expenditures upon which no actual saving in operating expenses can be shown, provided these expenditures will develop new business or prevent existing business from going to rival lines, to such an extent as will justify the outlay.

"But the ultimate result of all railroad expenditures is, and should be, net profit to the investor.

"While the question of what is economical management respecting maintenance-of-way and structures is one which the management of each property must solve for itself, we can certainly assist each other by a full and frank comparison of views and a discussion of the various elements that constitute an economical handling of our maintenance-of-way work. The establishment of certain recognized principles as the result of our investigations and discussions will materially assist our managements in adopting a policy that will lead to the truest and highest economy.

"I thank you, gentlemen, for the kind attention you have given me."

The reading of the address of the President was applauded by the convention.

The President:—The next in order will be the reports. I am going to announce the reports of the Secretary and Treasurer, but before we open up our general work, I wish you would all remember that we will not accomplish anything if we let a crust of ice form over this meeting. We should break that up in some way, and we want you to discuss freely the reports of the various committees after they are read. Ask the committees what they mean, and also criticise their statements, and thus assist in obtaining the fullest expression of opinion from the members of the Association. Mr. Hotchkiss, the chairman of the Entertainment Committee (who has done a great deal of quiet work in behalf of the entertainment of the members), states that on to-morrow night the closing feature of this annual meeting will be a banquet at the Victoria Hotel, and we have had a good many responses from members who want to attend. We want to know to-day, after the close of this meeting, or at any time during the meeting, preferably to-day, the names and numbers of our membership who care to attend the banquet. It is going to be a very pleasant affair, and I do not think any one of you will regret

attending. The hour has been changed from that printed in the notice—8 o'clock—to 7:30 o'clock, in order that we can let some of our members get away on the night trains that leave at 11 or 11:30 o'clock. The Secretary will now read his report:

The Secretary, Mr. L. C. Fritch, Superintendent Baltimore & Ohio Southwestern Railroad, here read his report, as follows:

Receipts from fees and dues to January 1, 1900	$2,825.00
Expenses to January 1, 1900	486.91
Net surplus on hand January 1, 1900	$2,338.09
Arrears from fees and dues	700.00
Total net surplus	$3,038.09

The President:—This is all the information we expect to let you have. We are trying to take in this money and spend it, but we have not succeeded in spending it all. What we have spent has been for printed matter and the ordinary expenses connected with the Association. Our expenditures this next year will be larger. After the close of this meeting we expect to issue the first number of our transactions, which will contain the papers that will be read at this meeting and the discussions of the same, and from that time on we expect to provide you with a record in print of all our meetings and the discussions and everything of that sort. The Board has gone into the matter quite largely, and we feel that this is an important part of our work. The greater part of our work—in fact 95 per cent of it—will be for the benefit of the railroad corporations, and after we have demonstrated to the managing officers of our corporations the efficiency of our organization, and that it will be a success, we expect to call on those corporations for a contribution to cover the expenses of our publications, in the same manner that the American Railway Association, the Master Car Builders, and some of the allied organizations do, among which we expect to take our place in the railroad work.

We will now call upon Mr. Sullivan's committee, the Committee on Railway Yards and Terminals.

Mr. Sullivan, will you please come forward, and as the Secretary announces the names of the members of the Committee, they will also please come forward and take their places on the stage.

Before introducing Mr. Sullivan, I desire to remark with reference to our discussions, that it would be of benefit to the reporters and would also assist the Chairman, that when any gentleman rises to address the Chair, he will kindly first state his name, clearly and distinctly, so that the reporters can get it correctly. I will now call upon Mr. Sullivan.

Mr. A. W. Sullivan, General Superintendent Illinois Central Railroad, Chairman of the Committee on Yards and Terminals, here read his report, as follows:

To the American Railway Engineering and Maintenance-of-Way Association:

The problems involved in the yards and terminals of a railroad stand in such intimate relationship to the operation of the line that the one is necessarily a corollary of the other, and a careful adjustment of each to the traffic requirements, immediate and prospective, is essential to the development of the ultimate capacity of the property.

It is conceived to be the function of this Committee to ascertain, by investigation, the conditions within its field of work which are common upon all lines of rail transportation, and by resolution to its elements to determine the principles that will serve to guide in the consideration of all like questions, to the end that there may be established a practice that shall meet with general approval and be recognized as standard.

The practical value of such work, it is believed, will naturally follow with the application of the results of the Committee's deliberations to the problems which arise daily in the work of expanding the facilities of the railways of the country to meet the ever-growing demands of a constantly increasing volume of traffic.

Comparatively few railroads are in a position to consider questions arising in connection with terminal work, free from the limitations imposed by the existence of facilities already established. In many cases the traffic conditions have so changed that the existing arrangements are inadequate to present requirements, and an entirely new plan is needed, while in others an enlargement of existing facilities will serve all necessary purposes. It is not always an easy matter to determine which course is the wisest to pursue, and an investment in the expensive work usually involved in such improvements is apt to be of a permanent character, carrying with it benefits or disadvantages dependent largely upon the skill and judgment of the designing engineer.

It is believed that many errors of design in such work may be avoided by the elucidation of the principles which appertain to the different branches of terminal service, illustrated by typical plans when necessary to a complete presentation, and it is in such work that the Committee hopes to accomplish a purpose useful to all who may be in need of the results of its deliberations and judgment.

The Committee invites discussion and desires an expression of the views of the members as to the direction in which its work may be most productive of immediately useful results.

A. W. SULLIVAN, General Superintendent Illinois Central, Chairman;
F. E. PARADIS, Chief Engineer Chicago Terminal Transfer Railroad, Vice-Chairman;
J. W. THOMAS, Jr., General Manager Nashville, Chattanooga & St. Louis, Nashville;
I. G. RAWN, General Superintendent Baltimore & Ohio Southwestern Railroad, Cincinnati;
E. E. R. TRATMAN, Resident Editor "Engineering News," Chicago;
S. P. HUTCHINSON, Assistant General Agent Pennsylvania Railroad, New York;
R. B. TWEEDY, Chief Engineer Wisconsin Central Lines, Milwaukee;
J. B. COX, Chief Engineer Chicago Junction Railway, Chicago;
C. W. HOTCHKISS, Chief Engineer Chicago Transfer & Clearing Co., Chicago;
C. S. SIMS, Jr., Engineer Maintenance-of-Way Pennsylvania Lines, Chicago;
W. S. KINNEAR, Principal Assistant Engineer Michigan Central Railroad, Detroit, Mich.;

Committee.

Mr. Sullivan, General Superintendent Illinois Central:—I desire to say, in supplementing the formal report of the Committee, that we have so far had but one meeting, which has been quite well attended, and at which, after considerable discussion, we found that there was quite a divergence of opinion as to what the Committee should really do and how it should get at its work.

The first thing that seems desirable to know in connection with the work of this Committee is, as stated in the report, the particular direction of work in which it can commence its investigations, so as to interest the largest number of members, and to put at once before them the greatest amount of useful information. By reference to the plan and scope of the Committee's work, it will be seen that it has quite a broad field. Its freight terminal work will include, in addition to the arrangements for the tracks, the relation to each other of different yards, and would necessarily include the location of structures, freight houses, docks, and the apparatus that is required either at the houses or in the yards outside, to facilitate the handling of the freight traffic of a railway in all its phases.

The problem will present different phases, according to local conditions—whether or not it is to be one entirely of land service

or in connection with lake or river traffic, or in connection with ocean traffic—whether or not the yards are to be made by reducing the natural surfaces of the ground to a level plane or by taking advantage of the inequalities of the surface and utilizing the grades to such advantage as they can be made to yield. The Committee has discussed some of the principles which underlie this work with a view to putting before the Association some idea of the Committee's attitude with regard to its work.

I would say that at our meeting the first question that presented itself in connection with a freight terminal was the length of track which should be taken as a unit for such work. That is, in itself, dependent directly upon the length of train. The train may consist of loads or empties. There are quite a number of opportunities for divergence of views upon that subject.

The next question was the number of tracks that could be economically operated from one lead—whether that should be six, eight, ten, twelve or more. The effectiveness of the operation of the yard will depend largely upon the skill with which it is planned as to convenience in movement and as to the facility with which the work can be done.

The Committee found that the question of the ratio of leads to yard tracks is one in which there was a great deal of difference of opinion and a great deal of doubt. One member expressed the view that it was a question whether it could ever be satisfactorily adjusted. However, that is one of the important questions which the Committee has before it.

Another question was the relation of axes of yards—whether a yard should be planned in a series of parallel yards or whether the relation of one to another should be that of a frog-angle, and in the development of a series of yards whether it should be along parallel lines, or radial lines, or what line would give the best development of the question.

Another question that it has had in mind is as to determining the shapes and areas of land which should be purchased by a railroad company in order to provide intelligently for its future needs, so that such investments would involve the acquirement of the least amount of useless property. I think the experience of railroads generally has been to purchase property in the form of squares, with the result that oftentimes a considerable portion of it cannot be used to good advantage.

The question of grades is also an important one. The matter of the minimum grade required for a gravity yard is one that does not appear to be well established, or, rather, instead of a minimum grade, I will say the best grade—the grade which will surely result in the car starting when released from the brake, and which will carry the car to whatever destination is required with such speed as will not involve hazard to the property.

The Committee feels that it has a field of useful work before it by investigating first and acquiring all the data that it is possible to obtain on the subject, and systematizing and reducing it as nearly as may be to axiomatic rules, to the end that a practice may be established which roads that have not a sufficient organization to take up these questions and sift them thoroughly—that such roads may refer to the work of the Committee and safely rely upon its recommendations as being good practice.

It looks forward to winning from the Association approval of its work, and to the attainment of a standing in keeping with the scope and importance of the subject assigned to it.

The best way in which the Committee can be helped with its work would be to have a free expression from the members in the shape either of criticism of what the Committee has done, or of what its members have said, or by asking questions to develop further the views of the Committee on this subject. (Applause.)

The President:—Gentlemen, the Committee is in your hands. We do not ask you to deal tenderly with them. Pitch into them, if you can. Don't be backward. If none of you gentlemen have the nerve to get up and say something, our entire meeting is going to fall flat and dead. There are among you some, I presume, who have ideas on this question, or some question that you would like to ask this Committee, about their methods of work, or their ideas in reference to the subject-matter.

Mr. G. W. Kittredge, Chief Engineer Cleveland, Cincinnati, Chicago & St. Louis Railway:—It seems to me, Mr. Chairman, that there is one thing that the Committee could discuss with profit, and that is the handling of the switches—the controlling of the switches at the entrances and exits of the yards by machinery—interlocking or otherwise—and while the chairman of the Committee did not mention that as one of the subjects, it can be discussed, and would probably come up in connection with

their work. I would suggest it to them as one which would be of interest. I offer it simply as a suggestion.

The President:—What have you to say to that, Mr. Sullivan?

Mr. Sullivan:—This Committee understands that there is another committee appointed upon that subject, and while it recognizes the advantages that would come from the rapid operation of switches in connection with terminal work, it does not consider that it is now within its field to consider that question.

Mr. H. D. Miles, Signal Engineer Michigan Central Railroad:—Mr. Chairman, that subject has been considered by the Committee on Signaling, and is mentioned in its report.

Mr. P. A. Peterson, Chief Engineer Canadian Pacific:—The Committee has said nothing with reference to the arrangement of platforms, baggage-counters and baggage-rooms for the convenient handling of baggage, so that it can be delivered to passengers arriving in the shortest possible space of time. It seems to me that this is one of the important points that this Committee should consider.

Mr. W. C. Cushing, Engineer Maintenance-of-Way Pennsylvania Lines West:—Mr. Chairman, the chairman of the Committee has stated that it would be difficult to say how long the tracks of the yard should be, but he does not say that it would be an impossibility to establish a relation by percentages between the different sub-yards and the one main yard. Every yard has to be divided into its sub-yards, and it might be possible to state a relation in percentages, that is, car capacity, between these different yards. For instance, if the trains are run in on the receiving track, there has to be a certain capacity in the yard below for handling that business. A great deal of money can be wasted by building these yards below too large—or too small—causing a cramping of the traffic. If it could be ascertained, for the guidance of the different members of the Association, what the percentage in car capacity should be between these two yards (and the same remarks may apply to the other portions of the yards as well), the information would be valuable.

Mr. T. F. Whittelsey, General Superintendent Toledo & Ohio Central:—Mr. Chairman, it has been my experience that tracks in yards are, as a rule, too short, and I think we should aim to have them long enough in all cases to enable the longest

possible train to be handled in the yard, and then to take care of the other features. If you desire to get access to the central part of a long string of cars, you could do so by a system of cross-overs or slip switches in the center of the yard. I would like to know whether the Committee would consider it practicable to introduce that feature into the yards—that of cross-overs in the center of a long system of tracks.

Mr. Sullivan:—The Committee is hardly in a position at this time to state what is good practice. It hopes to be able to determine that question in the course of its career as a Committee and as its work develops before it. The Committee is quite interested in these different questions, because they show the points in connection with its work to which its attention should be directed, and will be glad to hear from the other members.

Mr. C. A. Wilson, Chief Engineer Cincinnati, Hamilton & Dayton:—I have in mind what the President stated about making investments for returns. It seems to me that in designing a yard for a railroad, its present business and capacity is too often all that is considered. The business of the road is growing daily, and in designing a terminal for any railway, the principle should be borne in mind that that yard may be so extended as to avoid throwing away the first investment and provide for the future growth of the yard. We all know that a yard designed to hold a train a few years ago is only half long enough to hold a train of to-day, and frequently the whole yard has to be torn up and thrown away and a new one constructed. It seems to me that in designing a terminal, it should be so designed as to allow for development without the sacrifice of the first investment, and I would like to have the Committee, of course, bear that in mind.

Mr. H. J. Slifer, Superintendent Chicago & Northwestern:—It seems to me one of the most practical features to what might be called the country members, and I place myself with them, is a consideration of sub-heading No. 3, "Passing Sidings," and the elimination of facing-point switches in double-track districts.

Mr. W. G. Curtis, Engineer Maintenance-of-Way Southern Pacific:—I would like to suggest to the Committee that for some of their smaller problems they might formulate general specifications. Take, for example, an intermediate yard, where trains meet and pass, where train-movement orders are given and received, and through which locomotives are to be run without

being detached from their trains, and without backing or breaking up their trains, to have their fires cleaned, cinders drawn and to take fuel and water. The specifications embodying these requirements might be made and plans to fill such specifications suggested by the Committee. Most railroads nowadays are holding their business by making time. The days when freight trains could be started from one end of a division any time and get to the other end at some convenient time have gone by. Nowadays it is of prime importance that trains shall make time.

Mr. C. S. Churchill, Engineer Maintenance-of-Way Norfolk & Western:—The Committee raises one point about the gravity yards, stating that they had not settled upon the grade of the gravity yard that could be properly worked, or at least they had not decided upon what was the proper grade to recommend. It seems to me that that is quite a live question, and I think it is a question that a great proportion of the members here have settled on their roads. I think it is a question on which the results should be given out. I will say that on our road we have two gravity yards that we have worked successfully for many years, and through one of them we classify all our tidewater coal and have handled this coal successfully on an eight-tenths per cent grade—I should say a fall of seventy-five-hundredths per cent is a minimum limit for successful working. Now, I know that is subject to modification, as they say; cars will freeze up and work hard, and probably on some of the Northern roads you may find a nine-tenths per cent grade necessary in the winter; but it struck me, when that statement was made by our Committee, that it is a question on which we can exchange our views and help one another in designing new yards. We have one yard at Columbus, also a gravity, on an eight-tenths grade, that works successfully. As to the length of yards being governed by the length of the trains made up in them, or handled through them—recently we had the matter in hand of lengthening a yard on account of our getting heavier motive power, and we found that the necessity was overcome by building large cars. The fifty-ton car made it unnecessary to lengthen the yard materially, so that I think these questions are in many cases adjusting themselves. You will find that where they increase the size of engines, they are also increasing the carrying capacity of the car itself, so that the total length of the train is not so materially increased. That is, pro-

viding you are handling through the yard one class of business, as was the case in our yard, where we are handling tidewater coal in fifty-ton cars.

Mr. J. A. Atwood, Chief Engineer Pittsburg & Lake Erie:—Concerning gravity yards, I would like to say that the Pittsburg & Lake Erie has at its terminal a yard which is approached by two hundred feet of a lead on a 2-per-cent grade, ending at the point of the first switch, followed by a four-tenths of 1-per-cent grade through the switches, and that again by three-tenths of 1 per cent. These grades are used successfully in winter and summer, principally by empty cars. The heavy grade approaching the yard gives the car a start, which enables it to run a considerable distance on the lighter grades through the yard.

Mr. C. F. W. Felt, Chief Engineer Gulf, Colorado & Sante Fe:—I notice that the heading does not cover specifically the question of shop yards; I think that is quite important and hope it will be included. A question that comes up very often is the relative location of the various parts of a yard—the engine yard, for instance, in freight division yards, etc. I have frequently had a great deal of trouble in getting any agreement on the part of the transportation men as to where, for instance, the scales should be located.

Mr. E. P. Dawley, Division Engineer New York, New Haven & Hartford:—There is one suggestion that occurs to me on the subject that one gentleman referred to—that is the freight houses and similar properties in the center of cities. He spoke of getting property in the shape that was desirable and without unnecessary expense for the land, and I suggest for their consideration (and I think the point is one which may be reached soon), that is to make freight houses two stories, as we see done in some cities where the topography is such as to bring that about. In some places it has been done on that account, and in some other places it has been done where there is no other warrant for it than the expense of real estate. I suggest for consideration the idea of a two-story freight house, with proper grades for track and driveway approaches, so as to provide for the use of two stories for tracks or teams, or both.

Mr. F. H. McGuigan, General Superintendent Grand Trunk:—There is one important feature of the yard track which seems to have been overlooked; that is, the question of team tracks of

easy access. There are very few such tracks in any of our yards, the team track being usually a very long one, holding anywhere from twenty to sixty cars, which are generally placed during the night, and many of them unloaded before 10 o'clock next morning. If a car is required for a load, possibly at a point only a short distance from the team track, on which there is a suitable empty, you are unable to reach it because of the interruption to work and the danger of injuring those engaged in loading or unloading cars. For this reason I have for years thought that team tracks should be arranged by running short spurs, in pairs, from a lead or switching track, as nearly at right angles as possible, with sufficient room for wagons or driveways between each two pairs of tracks.

At the present time, our greatest need is the prompt movement of cars, and I am confident that where possible to arrange team tracks in large cities, as described, fully twenty-four hours can be saved in the movement of a majority of cars. If the Committee think favorably of this suggestion, I shall be glad to have them consider it.

Mr. Samuel Rockwell, Principal Assistant Engineer Lake Shore & Michigan Southern:—Mr. Chairman, we rebuilt two large yards during the past year, in both of which the fact that at once became most manifest was that it was absolutely impracticable to get additional land. I hope the Committee will not neglect to tell us what to do in the matter of rebuilding old yards where we have to adapt ourselves to the material we have on hand.

Mr. Geo. M. Brown, Chief Engineer Pere Marquette:—We built a yard and operated it very successfully where we had the tracks in groups of three, with cross-overs from the outside tracks to the middle track, the cross-overs being ten cars apart. The middle track was kept clear to switch the empty cars on, and was the only track on which the engine need work when pulling ten cars at a time on each outside track. Each of them held thirty cars.

Mr. McGuigan:—Wouldn't you lose three or four car-lengths of room on each track with such cross-overs?

Mr. Brown:—I think we would lose about 120 feet of room, or about three car-lengths.

Mr. McGuigan:—On the plan I suggest you do not lose any space except the ordinary clearance.

Mr. H. M. North, Principal Assistant Engineer Chicago Transfer and Clearing Company: —A previous speaker has mentioned that the Committee might take up the proper location of scales in the shop yards, and I would like to suggest, also, that the Committee take up the most advisable location of scales in freight yards and in classification yards. It would seem at first to be a very simple matter—one would say that the scales should be located at the entrance, but that would limit entrance into the classification yard to the speed with which we could safely weigh cars, and in that way it would deprive us of the use of the classification yard for more than the amount of traffic that could be so handled.

The President:—We will now permit Mr. Sullivan to close his case on behalf of the Committee.

Mr. Sullivan:—The Committee will, of course, consider carefully all questions of detail that arise in connection with this work, but it believes that its larger degree of usefulness will rest, at least for a time to come, in determining some of the questions which an individual is seldom able to determine satisfactorily. It is not often that one person has a sufficient range of experience, or, having the experience, has the judgment, to wisely determine questions which seldom arise in the experience of the individual. Even where a judgment is formed upon individual experience, such judgment can rarely withstand attacks which are brought against it in an association meeting, or even in a committee meeting.

It frequently happens that the judgment of the committee fails to withstand the criticism of the association. If that is so—if the collective wisdom of the committee cannot hold its own against the larger wisdom of the association—it is hopeless for the individual to imagine that he can alone solve the great questions that will arise in connection with railway terminal work.

The Committee will undertake industriously to gather the necessary data and will submit its conclusions to the Association at future meetings, and if those reports will serve the purpose of determining the order in which the facilities of a railroad should be developed to keep pace with increasing traffic requirements, so that the work that has been done to-day will be done perma-

nently, and instead of having to be taken up next year, or the year after, will merely have to be added to, it will be doing for the railways of this country a great deal of good. It will be doing for them, as a whole, a useful work, which will be of value to them.

The Committee thinks it can do something in that direction and will earnestly strive to accomplish a useful purpose and will seek to present to the Association in its different reports the subject-matter of its deliberations in a form that will not only interest them, but be useful to them as well.

I thank you, gentlemen.

The President:—I presume that the proper thing now will be to pass a motion to receive the report of this Committee and order it printed and extend a vote of thanks to the Committee. With your permission we will consider that such a motion has been made and passed unanimously, and will excuse the Committee for the present. (Applause.)

We will now hear from the Committee on Graduation.

I have the honor to introduce Mr. McNab, vice-chairman of the Committee, who will read the report of the Committee:

Mr. W. McNab, Assistant Engineer Grand Trunk:—I have the honor to present the report of the Committee on Graduation, but before proceeding to read it, I would like to state that the absence of the chairman, the Chief Engineer of the Union Pacific, is a source of regret to me personally, and I am sure that it will be a disappointment felt by all the members present. The Association will no doubt understand that this report is simply a blocking-out in a general way of the work that the Committee hopes eventually to accomplish, and the results that may reasonably be expected from its investigations.

I may say that this was the view that the immediate author of the paper had in its preparation, and this thought was considerably emphasized in his mind upon listening to the President's address this morning, in which similar views were so clearly and comprehensively stated.

I will now read the paper.

REPORT OF COMMITTEE I.—ON GRADUATION.

To the American Railway Engineering and Maintenance-of-Way Association:

This report is simply in skeleton form, but intended to indicate in the abstract the subject-matter to be ultimately dissected and collated by the

Committee. It will be our purpose to consider in detail as great a variety of facts and possibilities as opportunities offer, in order that formal reports, to be submitted at future meetings, shall be comprehensive and represent the best modern practice, based upon scientific methods.

There is an extensive range, and due consideration will be given to the limit of economy in original construction, in relation to subsequent maintenance, and how such may be modified in particular cases where the question of finance is a governing element.

Railroad work during the last quarter of a century has taught valuable lessons—not infrequently at great cost—and quite often more valuable experience has been acquired through failures than from that due to successes. In the membership of such an Association as this there must necessarily exist a vast amount of practical experience, covering all points embraced by the several subdivisions of these subjects, and it is the interchange of views of our members that the Committee expects, in order to supplement or modify the principles outlined in this preliminary report.

Standard cross-sections for cuttings and embankments, like standards for other items of railroad work, should be the outcome of the best theoretical knowledge, coupled with experience acquired from extensive and varied practice.

Unfortunately considerable variation exists in the standards of many of the railroads; some only differ in minute points of detail, while others vary more substantially, the logic of the situation being the superiority of some and the inferiority of others.

That such a want of uniformity in standards is the case, even where similarity exists, not only in formation material, but also in climatic influences, and class of railroad using these respective standards, it may reasonably be inferred that, in some, defects exist; and, no doubt, if the nature of these differences be investigated, and the governing principles of the best theory and practice combined be rightly demonstrated, it will result in improved plans, tending to more economical and, at the same time, more efficient maintenance. To this end it is the intention of the Committee to collect and analyze the drawings of cross-sections of standard roadbed of the lines having membership in the Association, together with their specifications covering the work.

After arriving at a decision on the best form of roadbed under ordinary circumstances, for the respective classes of material with which embankments are constructed, or through which the railroad passes in cuttings, consideration will be given to the question of a too rigid adherence to standard or stereotyped plans in localities where, from special surroundings, or local peculiar circumstances, modifications should be made. As instances, the relationship of the angle of repose of any given material to height—i.e., whether or not it is constant; the actual angle of repose most suitable for the various kinds of material; the greater capacity of roadbed ditches for deep cuttings, on account of the greater quantity of surface water shedded by these slopes; the capacity of roadbed ditches increasing toward their outlet in cuttings of extensive length,

through which the track may be level; troublesome pockets of quicksand, which may occur, and for considerable extent; how far, in northern latitudes, the matter of snow in cuttings unprotected by coverings affects the contour of the standard, for there are instances of "bad spots" in certain cuttings, where atmospheric and other local conditions produce drifts not altogether preventable by snow fences.

Protection of Slopes.—The permanent character of cuttings and embankments being such an important element in maintenance, investigation will be made regarding the immediate and extraneous causes which necessitate protection. Consideration will be given to the character, method and extent of that protection, as governed by the physical and financial conditions and prospects of the railroad, and to the more ornate, but equally effective, means to be adopted for the neighborhood of town and suburban stations.

Effective drainage being the fundamental element of protection to slopes, the methods for such will bear upon the character of the soil and the source and quantity of water to be taken care of. The contour of the slopes, of cuttings and embankments, with reference to the shapes ultimately taken by natural causes, will be investigated, in order that the general practice of angles in intersecting planes may be modified advantageously.

Notes will be made on the friction and cohesion of soils in reference to the theory and practice of retaining walls, and, in regard to the latter, their various styles, method of construction, and materials of which built—masonry, piling, wooden wharfing, etc., and instances in which each of these methods may be used to advantage, and the particular provisions that will be best to make with reference to their foundations, drainage, etc., will be dealt with. Not only will the question of retaining walls in cuttings and embankments to prevent landslides be investigated, but also the protection of embankments from scour by water in large volumes, either by current or waves, including rip-rapping, revetments, paving, etc., and the best plans to be adopted to meet them in a general way. In this particular the Committee hopes to be assisted by descriptions of particular cases.

Regarding sodding and seeding, it is evident that the slopes should have a certain amount of preparation beforehand by being put into reasonably proper shape, but the necessity in certain instances of a coating of soil, the quantity and thickness of such soil, quality of the field sods, their thickness, the method of staking them down, the best class of seed, according to climate and soil, and the method of saving it, as well as the cost of doing so, will all receive due consideration.

The planting of willows will receive attention, together with the nature of the soil for them, the manner in which their roots permeate the ground and act as a check against any tendency of the earth to move in large quantities, and their susceptibility to close trimming without impairing their vitality to a marked extent. Under this head will come also the advantage of planting scrub bushes in abundance on banks with a tendency

to break or slide, or where, in the case of sandhills, the material is likely to be reduced by being blown away.

When building a railroad it is often the case that really good material from cuts is wasted, in order to save haul, whereas, at reasonably additional first cost, it might, in many instances, be saved and dumped over embankments to a sufficient depth to allow the quick formation of a good sod from seeding, which would not wither up during droughts.

Improvement of Grades and Alignment.—In the matter of gradients and curvature, the forethought of even the most far-sighted of the earlier engineers has proved in recent years to have been insufficient to cope with the economic principles of modern transportation. This section will, therefore, naturally be considered as referring not only to the improvements of existing lines, but also to the alignment for proposed roads—although each line will probably have its own unique features, commercially and physically, so that comparisons cannot be made in detail; still there are general features that can be based upon the experience of the older lines, and it is expected that the methods to be suggested will be such that they can be reduced to a practical form.

Of course, there are many instances where the physical conditions of the country traversed will only permit of sharp curves and steep gradients, except at an absolutely prohibitive cost. At the same time, the railroads, or sections of railroads, are equally numerous where improvements can be made in curvature and gradients, which, in the aggregate, will largely reduce the track and rolling-stock maintenance, as well as cost of transportation, and, in a large ratio, to the actual outlay for these improvements.

In the earlier days, on the more important railroads, the question of ultimate cost of maintenance and operation does not seem to have been as important a factor as that of shortening the line between the main points, the results of which were "ruling" gradients, and frequently at awkward points; while in later times, in many instances, the other extreme has been resorted to and unnecessary circuitous locations adopted.

The question of what is the steepest grade or sharpest curve for economical operation cannot be answered without reckoning on the immediate physical conditions of the road in proximity to each particular ruling condition, and in this the Committee expects to make investigations into the train-resistance generally, due to grades and curves, and the actual cost of overcoming this resistance in actual practice.

Consideration will be given to the features in which a new location may be preferable to improving the present one; also to particular cases of reduction of curvature, as well as that of gradients, in both of which latter cases more or less new location may be involved, and the substitution of vertical curves for the intersections of planes at changes of grade.

These improvements, together with others of a minor character, will also be considered in reference to extension for double-tracking, in all of which steam-shovel work and other methods will be dealt with in regard to their most economical and systematic workings.

The elevating or depressing of tracks in large cities in order to abolish

grade crossings will be considered, in reference to the best methods to minimize the cost and to give the least interference to traffic during the progress of the work.

TUNNELS—VENTILATION AND MAINTENANCE.—It will not be the province of the Committee to enter into the question of the necessity for tunnels in certain locations, nor the simplification of the problem of ventilation by the substitution of other motive power for ordinary coal-burning locomotives at present in use, but rather to deal with the principles of ventilation as applicable to tunnels of various lengths, sections, and features of location, with present class of locomotives.

The condition under which natural draught for ventilating purposes is effective will be considered, and the elements tending to retard such; and in regard to artificial means, when such is required—the nature of failures, the various methods adopted, their capacity, effectiveness, requirements, cost of working for the results obtained, etc., will receive consideration, as well as the atmospheric and other conditions under which maintenance is necessary, and the means adopted to that end.

J. B. BERRY, Chief Engineer Union Pacific, Omaha, Neb., Chairman;
W. MCNAB, Assistant Engineer Grand Trunk Railway, Montreal, Can., Vice-Chairman;
J. A. ATWOOD, Chief Engineer Pittsburg & Lake Erie Railroad, Pittsburg, Pa.;
R. C. BARNARD, Engineer Maintenance-of-Way Pennsylvania Lines West, Cincinnati, Ohio;
G. M. BROWN, Chief Engineer Pere Marquette Railroad, Saginaw, Mich.;
H. BALDWIN, Engineer Maintenance-of-Way Cleveland, Cincinnati, Chicago & St. Louis Railway, Indianapolis, Ind.;
C. DOUGHERTY, Roadmaster Illinois Central, Chicago;

Committee.

The President:—Gentlemen, if the Association discusses this subject-matter as well as the Committee has presented it, we will have a very valuable discussion. The matter is now open to the members. I do not want you to think that the question is exhausted, because it is not.

Mr. D. Bontecou, Chief Engineer Kansas City, Fort Scott & Memphis:—It occurred to me, in hearing the report of the work of this Committee, that while sometimes it is not difficult to compute the advantage of spending money in improving a maximum grade, the operation of the grade being a source of heavy expense, yet there is a class of very difficult questions that come up in case of the small grades, where you know perfectly well that a train will run down through a sag and up to the other side by its momentum, with no extravagance in fuel or train expense, and everything safe except, possibly, the chance

of a break-in-two accident, or some other inconvenience which may only occasionally arise. I think there is no doubt but that we always realize that in a great many of those cases it is not worth while to expend money. But cases arise, as details of extensive plans of improvement, which are difficult to decide. I believe that for my own part I would prefer to have guidance on questions of that kind in deciding how far it is worth while to go in the improvement of short, unimportant grades.

Mr. McNab:—The point that Mr. Bontecou has taken the Committee has in view, that is, the physical conditions of the road on either side of the grade or grades proposed to be reduced will have to be taken into account. I appreciate Mr. Bontecou's remarks. The steepest grade may not necessarily be the ruling gradient; but the direction of the heaviest traffic, and the features of the road on either side of the grade proposed to be reduced which accelerate or retard momentum will all be duly considered.

Mr. O. D. Richards, Chief Engineer Ann Arbor Railroad:—I think the original grades on most railroads are established too low for economical maintenance after they are in operation. I wish the Committee would take that into account, and by recommendation or otherwise, call attention to the matter. It would, perhaps, have a tendency in the future to correct the error, even at the expenditure of a little extra time and money, as it would be cheaper in the end.

Mr. S. P. Hutchinson, Asst. Gen. Agent Pennsylvania Railroad:—In regard to the remarks of the gentleman about a mistake that is sometimes made in reducing small grades, I may say that on the division to which I am attached our heaviest grades are not our controlling grades, that is, when we have a good approach, the train gets a momentum and can get over without any trouble whatever. Our ruling grade is at present nine-tenths, our heaviest grade is a foot and three-tenths, but we are now considering the question of reducing our nine-tenths grade, because that controls our tonnage.

The President:—Some years ago I was on a line where the question of changing the alignment had been very thoroughly considered, and for several reasons, three or four different locations had been adopted from time to time, and afterward abandoned. On one or two of those lines there were tunnels which

the engineer said the company had for sale. I think Mr. Curtis can tell us something about it.

Mr. W. G. Curtis, Engineer Maintenance-of-Way Southern Pacific:—I thought you were talking about the Southern Pacific. Those changes that you referred to were washout changes, I think, that were in the Solidad Cañon in Southern California, where there was certainly a climatic change. The railroad had been built for about seven years, and at that time the cañon showed no evidence of great floods; trees of great age were growing upon it, none of the older people who had lived there—the Mexicans—had any knowledge of floods, and the road was built close to the bottom of the cañon. In 1884, some eight years later, there came a series of tremendous floods, and before they were well over, among other things, the bottom of the valley had lowered itself something like twenty feet. Commencing at the lower end of the cañon, it cut down a precipitous face for itself and gradually worked back, until some eight or ten miles through the cañon had been changed.

That same sort of thing occurred later in Arizona, in the Cienega Cañon, the bottom of which lowered itself eight or ten feet. When the road was built there was not the slightest evidence that the floor of the valley had ever been lower, although after this erosion occurred the rock walls of the cañon were worn smooth, showing that that condition had existed there before.

The same thing in the Sonoita Cañon, Arizona, is going on at the present time. We have guided that channel to suit ourselves. We have cut down the trees and guided the course of the erosion and have got the channel into a pretty good line there.

About the momentum of grades, we are thinking about them a great deal lately in connection with the locomotive tonnage ratings. As has been suggested, the locomotive problem has been greatly changed in recent years. Our locomotives to-day are twice the capacity of those of ten or fifteen years ago, and in connection with the rating of locomotives, to settle all questions open between the maintenance people and the motive-power people, a committee has been appointed made up of the superintendents of motive power and engineers of maintenance-of-way and mechanical engineers of the Southern Pacific Company.

Well, we began the thing and have nearly completed it now on a theoretical basis. We have plotted an operating profile

continuously over the entire line, and that method has developed the momentum of grades. Of course, it is a fact that the actual maximum grade is not the ruling grade in many cases.

I know of one instance where in three hundred miles the average rise of a valley is such that on the shortest line a ruling grade of four-tenths per cent could be adopted for that entire three hundred miles; the present maximum grade is something over 1 per cent, and we find, in connection with this locomotive rating investigation, that to get the best out of that situation—to get the equivalent of four-tenths per cent grade—we need not change line or grade very much when the line is remodeled, as it probably will be, and grades reduced to the equivalent of four-tenths per cent. It will still have many 1-per-cent grades descending into and rising out of the sags.

In connection with locomotive rating, we define one unit of locomotive power as 1,000 pounds available at driving-wheel rail contact to haul locomotive and train, and from a continuous virtual or operating profile is determined the load in "M's" that can be hauled per unit of power. A load of one thousand pounds we define as one "M." Individual locomotives are rated by multiplying their units of power by the load haulable per unit. We rate our locomotives entirely on a tonnage basis.

The increase in the locomotive power, of course, introduces a great variable into all these questions of grade reduction, since we are assuming a maximum trainload. With us, fifty thirty-ton cars, fully loaded, is about as many cars as we can safely pull in a train, and we are assuming that no larger locomotives will be used than necessary to pull that maximum train over each division.

The method of this Southern Pacific tonnage-rating committee, I do not suppose, is new, but if the Committee of the Association, whose report is now under discussion, wishes a full statement of it, I am sure our General Manager will be glad to give it to them.

Mr. H. G. Kelley, Chief Engineer Minneapolis & St. Louis:—The scope of the matter to be considered, as outlined in the report of the Committee upon Graduation, is so complete that little can be said at the present time in the matter of suggestion, but among the many items which occur to my mind, I would like to call to the attention of the Committee the trouble experienced

in maintenance-of-way departments by sliding and unstable banks.

The first consideration would be to arrive at the cause of the trouble, and from my own experience I would say that the cause of sliding banks, in many instances, arises from defective original construction, as well as from bad material. As an example, I will call attention to one item that came to my attention some years ago. An embankment 25 feet high and about 1,000 feet long had commenced sliding shortly after construction, within a period of three or four years.

The ordinary method of curing troubles of this kind was applied in this case, which consisted of dumping more material upon the already overburdened bank, but, naturally, this did not reach the trouble, and when the matter was brought to my attention, a careful study of the nature of the soil on both sides of the embankment was made, and it was found that the top soil was a light clay loam and the substratum a heavy blue clay. I then cut the bank in two, and found that the lower portion of this embankment had been made from borrowed material, and the upper portion had been overhauled material from surface cuts and that there was a well-defined plane of cleavage between the two materials. The incline runway of the scrapers was well defined and the sliding of the embankment occurred on this plane. There had been expended upon this embankment, up to the period when it came to my knowledge, some $10,000.00. It was cured permanently at a total cost of $1,200.00, by the following method: We excavated longitudinal trenches on the side slopes and foot of the embankment and then cross trenches between these longitudinal trenches. These trenches were then filled with old pile heads and ties and refilled with the clay excavated from them. The mass was then fired and smoldered for upward of six weeks, more clay being added in the trenches as the material in them settled down.

The result was that the sliding bank was practically made into a mass of brick, and has never moved or settled since that date, about six or seven years ago. I have applied this method since then to other embankments which contained clay, and with uniformly successful results. The point that I desire to draw is, that the original construction of this embankment was at fault, for the reason that the borrowed material used in making the

base of the embankment should never have been put in with an inclined-top plane. Had it been put in level the probabilities are that the embankment would not have slid.

The President:—We had a very singular experience on the Illinois Central Railroad, in some of our embankments. We have had embankments that were constructed fifty years ago, and up to a few years ago showed no signs whatever of sliding. During a wet season—which was no wetter than the usual seasons we had passed through before—we had some very extensive slides, and it is quite a serious question whether there is not something in an idea that one of our subordinates suggested—that with the increase of speed and weight of trains, if there is not an effect on the embankments and on the masonry that tends to disintegrate them and to overcome the cohesion between the different particles of the mass, that tends to weaken the embankments, particularly where the service is very severe—where trains are numerous and the weights of trains are heavy and speeds are high.

Is there any further discussion on this question, gentlemen?

Mr. C. F. W. Felt, Chief Engineer Gulf, Colorado & Santa Fe:—I think perhaps some of you have had experience in running across some old line that was laid with very choppy grades—short grades that did not control the train-loading at all, but where the question of break-in-twos came up. I think that is a point that should be investigated.

Mr. McNab:—The Committee will take note of the remarks that have been made by the several speakers and give them due consideration. I may say that we have quite a contract before us, as the Chairman has intimated, and while we do not expect to cover the whole of it in one year, or even two years or more, it is our purpose to do our work thoroughly, and by the next meeting to have some parts of it in sufficient shape that it will stand against an overhauling—as our President practically expressed it a while ago—and we have in view that with these reports from year to year, the output of this Association will practically become the text-books on maintenance-of-way matters as time goes on.

Personally, I think that fewer books on maintenance-of-way will hereafter be written by private engineers, and that the records of this Association will be looked upon as standards in that respect for the time being. While, as I say, we have a con-

tract before us, our Committee is small, and it may be necessary for us to increase that Committee, and it certainly will be necessary for us to apply to members of the Association to supplement our information and knowledge, it is to be hoped that this information, when applied for, will not be shelved over into some more convenient season.

Of course, now we are all enthusiastic and we all have sanguine expectations of the results that are to be obtained ultimately from these reports, and while we will all leave here tomorrow with the very best intentions, the cares and routine of everyday life will come up and there will be the tendency to postpone Association matters until some other time.

Now, it seems to me that to the members generally in everyday life some thought will occur to them now and again that would be of use to the Association, and if these little thoughts were just jotted down from time to time, not necessarily to be acted upon at the moment, but just entered in a notebook, or in some other form, and elaborated as opportunity offered, good results might be obtained.

We know that winter is going away and spring, with spring work blending into summer work, is almost at our doors, but still the busiest man is often the man who has the most leisure if he is systematic, and if some little means of the kind I have suggested were adopted, the Committee, in applying to the members generally, will have no difficulty in obtaining information, and obtaining it in as speedy a manner as circumstances will warrant.

The President:—I think Mr. McNab's remarks are very pertinent, indeed, and the suggestions are valuable, and I hope you will carry them out. He is right in thinking that the reports of these committees in time will be text-books on these matters; and there is also a matter that is in our minds, and that is, that these reports at this meeting may be introductory to those books. And another thing he is right in, and that is, that we expect to cover the entire field, and we are practically in a trust on maintenance-of-way matters, if we do our duty.

If there is no objection, we will consider the former motion made and carried, and we will receive the report and thank the Committee, and excuse it temporarily.

Recess of ten minutes.

The President:—The Committee on Buildings will please come forward.

Before we take up the work of this Committee, the chairman of the Entertainment Committee wishes me to announce that the train on the Santa Fe will leave at 2:30 p. m. sharp, from the Dearborn-Street Station. We also want to announce that if there are any here who are invited as friends of the membership of the Association, who are not members of the Association, whether they are supply men or not, they are perfectly welcome to go along on that train.

We would like to say, in reference to the supply men: We have endeavored to divorce our Association from the supply men solely for the reason that there have been associations of this kind who have relied on the supply men to entertain them, and carry them around at their annual meetings and that sort of thing, and we did not think that was proper. We have formed our Association for the scientific treatment of our business, and we want to conduct it in a business way, and we want to stand on our own bottom. (Applause.) We want to treat the supply men courteously, because they perform a very important function, and while we do not want to be their guests as an Association, we have not any objection to the individual supply men being our guests and we want them to be regarded as our friends. But this Association is for a distinct purpose—honest, hard work, and not entertainment.

We will now hear from the vice-chairman of the Committee on Buildings. The chairman is Mr. Berg, but he is unavoidably absent.

Mr. H. W. Parkhurst, Engineer Bridges and Buildings Illinois Central:—I should say by way of preface that the introductory paper is by Mr. Berg. It is a brief review by the chairman of the Committee as to the best method of procedure for conducting the work of the Committee on Buildings. I would further say that, owing to the fact that no two members of the Committee live in the same place, there has been no previous meeting of this Committee. They are practically strangers to each other.

REPORT OF COMMITTEE VI.—ON BUILDINGS.

To the American Railway Engineering and Maintenance-of-Way Association:

The following is a brief review by the Chairman of the Committee as to the best method of procedure for conducting the work of the Committee on Buildings:

The scope of the Committee's work is so extensive that the only possible method to handle it properly will be to appoint sub-committees. Knowing full well from my own experience for years that the chairman of a committee generally does all the work, I believe if the two principal subjects should be divided among the twelve committeemen as chairmen of subcommittees, that we would get the best results. On the other hand, it is preferable to have more than one member on a committee.

I suggest, therefore, that the work of the Committee be grouped under six heads, and two members assigned to each group, or that the Committee be extended so as to have twenty-four members, two to each of the twelve subjects.

Each member should be asked for his preferences in the choice of subjects, giving first, second and third choice. The assignment of subjects could then be made with reasonable certainty that each subject would be handled by an expert, or at least the work be one of pleasure, with corresponding profitable results to the Association at large.

As the general principle underlying the Association's work is the collecting, classifying, systematizing and disseminating of engineering information connected with railroad work, and not the aim to create official standards sanctioned by official representative votes, the work will be largely dependent upon the enthusiasm displayed by the individual members of the Committee, more particularly the sub-chairmen. Success will be proportionate to the care shown in the choice of the proper men to handle the various subjects.

I suggest that the Chairman of the Committee should make a canvass of all members as to their preferences, and then assign the subjects to them. That the two or more members assigned to a sub-committee should prepare a report, which should be transmitted to the Chairman in time to enable him to examine same and send copies to all members of the full Committee some time prior to the annual convention. That, prior to the convention, say the day previous, the full Committee should be called together and pass on the reports of the various sub-committees, and determine whether to present them to the convention. The report of each sub-committee should be signed by the chairman and members of the sub-committee, and further by the Chairman of the Committee on Buildings, with notation that the report had been approved at a meeting of the Committee.

One point should be carefully watched—namely, any attempt to advertise patented or trade articles. Further, the reports should be more in the nature of summaries of best practice and not detailed descriptions.

In many cases drawings would necessarily have to accompany the

reports. If properly prepared tracings or photographs are furnished, the expense of publication is small.

There is no doubt that all engineering work is tending toward specialties, and railroad architectural and structural work is not an exception. The field is large, and railroad buildings daily being more and more recognized as a specialty, necessitating a knowledge of the railroad requirements, in addition to ordinary structural ability and designing experience. The average architect is lacking in knowledge of the railroad requirements, whereas the engineer is wanting in architectural taste and experience. The railroad architect and structural designer is the result, and the work of the Committee on Buildings will play an important part in the development of this important specialty of railroad work.

W. G. Berg, Chief Engineer Lehigh Valley Railroad, New York, Chairman;
H. W. Parkhurst, Engineer Bridges and Buildings Illinois Central, Chicago, Vice-Chairman;
P. D. Ford, Chief Engineer Long Island Railroad, Richmond Hill, N. Y.;
E. C. Macy, Engineer Iowa Central, Marshalltown, Iowa;
C. E. Bryan, Superintendent Maintenance-of-Way Ohio River Railroad, Parkersburg, W. Va.;
C. Millard, General Manager Chicago, Peoria & St. Louis, Springfield, Ill.;
B. C. Gowen, Chief Engineer Wisconsin & Michigan Railway, Wausau, Wis.;
M. W. Cooley, Assistant Engineer Construction Baltimore & Ohio, Baltimore, Md.;
A. S. Markley, Superintendent Bridges and Buildings Chicago & Eastern Illinois, Danville, Ill.;
C. T. Norton, Superintendent Road Department Mexican International Railway, Ciudad Porfirio Diaz, Mex.;
H. Pierce, Engineer Maintenance-of-Way Chesapeake & Ohio, Huntington, W. Va.;
I. F. White, Superintendent T. & S. Cincinnati, Hamilton & Dayton, Hamilton, O.;
G. W. Vaughan, Supervisor Bridges and Buildings New York Central, New York;
J. D. Isaacs, Second Assistant Engineer Maintenance-of-Way Southern Pacific Company, San Francisco, Cal.;

Committee.

The President:—In reference to the first suggestion made by Mr. Berg in his report, I would like to explain to the Association the manner in which these committees have been selected.

In the first place, the Board of Direction has selected the chairman and vice-chairman of the committee; then it requested the chairman to nominate his own committeemen. Those nominations came to the Board, and it was found, as expected, that a

great many times one man was nominated on half a dozen different committees, and, of course, it was necessary for the Board to supervise the selection of these committees and to make a selection so that one man might not be on more than one committee, and in order that different railroads of different parts of the country might be properly represented.

It was realized that there would be some difficulty in getting these committeemen together, but a general representation on the committees was very essential. The question of the men getting together is a matter that will gradually work out itself.

In regard to the number of men on the committee, if any chairman desires more committeemen, it is his privilege and duty to notify the Secretary that he would like to have his committee increased by so many members, and if he would like to have such and such gentlemen serve on that committee. If he exercises care in selecting men that are not on other committees the Board will conform to his wishes as nearly as possible, but it is not desired to put the work all on one set of men. It is desirable to extend our committee membership to the entire Association.

The chairmen of the various committees will bear this in mind in making nominations for the extension of the membership of their commitees. The question is now open for discussion.

This preliminary report, of course, is merely an outline of the way this work should be carried on, but if there is no objection, and it is desired, and any member has any suggestion—not only in regard to the matter of the committee-work, but in regard to the way the subject should be treated—it will be well for them to make their suggestions at this time, or ask the Committee how they intend to handle it.

Mr. E. E. R. Tratman, Resident Editor "Engineering News:"—I would like to suggest that this arrangement practically makes the Committee's report a compilation of sub-committee reports. According to the plan outlined, the sub-committee reports will only be considered by the general committee one day before the meeting. That will necessarily be largely perfunctory; there will not be time to digest and consider the various subjects. It seems to me that it would be better for the subject to be con-

sidered by the Committee as a whole and the result embodied in one general committee report.

The President:—I think that this criticism is very well taken.

Mr. Parkhurst:—The practical difficulty is in getting the Committee together for the general consideration of a series of sub-reports in any other way except prior to some convention or some important occasion. The men are scattered from Maine to California, or from Oregon to Florida, and it is pretty hard to get them together, because they are busy men, and there would necessarily be very few that could attend such meetings. That was the reason for the suggestion that these sub-committee reports be considered at a time just prior to the annual convention or at the time of making the full report before the convention. I think they might be supplemented by correspondence and transmitting them from one portion of the Committee to another, but I do not very well see how we could insure any fuller discussion in the Committee.

The President:—Mr. Sullivan, you have had a great deal of experience in handling these committees in the American Railway Association. Will you give us your ideas on the subject?

Mr. A. W. Sullivan, General Superintendent Illinois Central:—With reference to the manner of performing the work specified by the Committee, I apprehend that it will fail to serve the most useful purpose that comes from committee-work, and that is to develop the collective wisdom of the Committee.

The strength of committee-work usually lies in the fact that it gives the opinion of no one person. The opinion of some one person may start a movement, may direct the line along which inquiry is made, may possibly direct the thought of the committee, but the judgment of the committee will of necessity carry weight, if it be that of the committee as a whole, and, being the judgment of many persons, is more likely to stand against the broader judgment of the convention.

The point I had in mind, listening to the report of the Committee, was, What suggestion does it contain as to a typical plan of a station? Possibly I may not have taken a right view as to the scope of the Committee's work. My idea as to that scope was that it should include the uses of the buildings as well as the construction of them; in fact, the use of the building is more likely

to be the higher purpose, and unless there can be a consensus of opinion resulting from investigation by the Committee as a whole, I do not see how they can satisfactorily develop typical plans for the various classes of buildings required.

It seems to me that, to get the best results along those lines, would necessarily involve the work of the Committee as a whole; to make the work of the Committee most useful to the Association would be to lay before its members typical plans which the Committee will stand back of and say, "These are the best plans to meet the requirements of actual service under given conditions."

Then any member who has occasion to consider the question would naturally turn to the work of this Committee and recommend the adoption of such of its plans as would be most useful, and in that way its work would tend to bring about uniformity of service at stations, as is being done in other branches of railway service.

Mr. Parkhurst:—I think the conception of the Committee, as indicated by the last speaker, is somewhat different from that held by the chairman of the Committee. If you will note, he says that the "principle underlying the Association work is collecting, classifying, systematizing, etc., engineering information," and not "to create official standards sanctioned" by the Association. With that idea in mind I think the plan of work as outlined would be more satisfactory, perhaps, than it would be with the other idea in mind—that is, preparing a standard, or suggesting a standard; that would be a development which would follow the ascertainment of present practice. The present practice might be obtained from sub-committees of one or two men and collated.

The labor of correspondence and combining plans, something of that kind, can be handled by a small committee, just as well as by a large committee; then the action of the large committee might be taken to suggest, and perhaps present, a standard or typical plan of a given class.

The President:—The policy of the Association in all these matters will be in the hands of the Association. So far as this policy is announced to date it has been an expression of opinion of a majority of the Board of Direction. It was thought that the idea of committee-work should be the col-

lection of facts, then follow with recommendations, but that was a mere suggestion as to the way the work should be conducted on some committees; the question necessarily involves the consideration of Mr. Sullivan's suggestion.

The object of these discussions is to bring out and get the ideas of the members of the Association themselves as to what would be the proper and the best way to carry on committee-work, and we want the fullest and freest criticism and suggestion of ideas in relation to it.

Mr. Sullivan:—One word more. I would like to have the Association consider whether or not I am correct in the assumption that there is a distinct difference between standard plans and typical plans. For instance, I feel that the Committee can submit to the Association typical plans, illustrative of its idea, without in any manner committing the Association to an indorsement of that plan; but, on the other hand, a standard plan, accepted by the Association, would carry with it the weight of the Association indorsement, and it is quite probable that on many things the Association would not be willing to indorse any given plan as being a standard. It could have no objection to a plan being submitted by a committee as a typical plan, and in that way, by holding to that distinction, we can, I think, enable the committees to submit the plans with the committee's approval, which can go forth in the proceedings of the Association without, however, necessarily carrying the indorsement of the Association.

Such plans are useful to the members at large throughout the country, and it is quite desirable that there should be some means of laying them before the railway people generally, but without wishing to carry with it any official indorsement. It has occurred to me, and I submit the idea to the Association at this time, that there is a proper distinction between typical plans and standard plans, and it would be of value, I presume, to this Committee—I know it would be to the Committee of which I am chairman—to know whether the Association indorses that idea.

Mr. C. A. Wilson, Chief Engineer Cincinnati, Hamilton & Dayton:—I think Mr. Sullivan has very clearly presented the difference in that distinction between typical and standard in

the work of the Committee that he has been engaged on and the committee-work that would be done by this Association.

The American Railway Association, probably, can establish standard plans, being an association of railways and not of individuals. This is an association of individuals and not of railways, and it seems to me that that idea of Mr. Sullivan is one that we ought to follow—not to attempt to establish standards, but types.

Mr. W. McNab, Assistant Engineer Grand Trunk:—I would ask the vice-chairman of this Committee whether what will be considered in reference to standard or typical plans (whichever they may be called), will have reference also to the general layout and the general conveniences that will be afforded the patrons of the road, and whether it will deal also with the external features of the building itself.

There are instances where railway stations have been constructed at great cost, and on taking up guide-books of the country descriptive of the city or town in which the respective stations are located, one finds amongst the elaborate specimens of architecture the railway stations particularly noted. One looks at them and finds, perhaps, large towers and other attributes of architectural elegance, which do not add particularly to the comfort or convenience of the patrons of the road. In such cases those cities or towns, as a general rule, do not contribute anything toward this advertisement that they indirectly get. I mention this merely that the Committee might take into consideration whether or not more money should be expended on the conveniences that the traveling public and the patrons of the individual roads are to get, as against the advertisement that the city or town is getting for some of its architectural features at the sole expense of the railway company.

Mr. Parkhurst:—I think this suggestion is a very desirable one for consideration, and the Committee will undoubtedly take it up. As I have already stated, unfortunately the Committee has not had a meeting, and no elaborate method of procedure has been evolved as yet.

The President:—In reference to the remark of Mr. McNab, I think our Committee should do one thing which a great many of our architects have failed to do, and that is to arrange for the decoration of the construction, and not arrange for the

construction of their decorations. It is one great trouble with many of our railway stations that that principle has been overlooked.

Mr. Thomas Appleton, Chief Engineer Copper Range Railroad:—In designing shops, roundhouses, freighthouses and buildings of that class, it might be well to pay more attention to the methods of slow-burning construction, commonly known as "mill construction." Very often we find beams, rafters, purlines and jack-rafters, built one on top of the other, presenting a great many surfaces for fire to attack, and the pieces are so small in cross-section that a small amount of burning will weaken them so that they give way. In mill construction, a smaller number of large timbers is used, with plank instead of boards for sheeting, so that the fire risk is greatly reduced.

In regard to railroad architecture, it seems to me that the most important consideration in designing a station is to get convenience for the uses of the railroad and its patrons, as required by the business of the road at the point in question. After planning the necessary rooms, offices, etc., there is no reason why the building should have an ugly appearance. It is well to have some appropriate ornamentation, but the decoration should be subordinate to the convenience and economy of construction. It is not necessary that all buildings for a given purpose should look alike. The word "standard" is sometimes overworked. There might well be some variety in the exterior appearance of railroad stations.

Mr. H. G. Kelley, Chief Engineer Minneapolis & St. Louis:—As all buildings are used principally by departments other than the maintenance-of-way department, I would suggest that in the consideration and presentation of types by the Committee, due weight should be given to the experience and opinion of the departments using the buildings. For instance, in the case of freight stations, we should have the opinion, not only of the transportation department, but of the freight department; the same with passenger buildings, and with motive-power buildings. In other words, that due weight should be given to the opinions of the members of the department who use the buildings and who know the necessities of the design.

Mr. D. W. Lum, Assistant General Superintendent Maintenance Southern Railway:—The question has taken a turn that

I do not quite understand, and I am asking for information. There are many points upon which many of us may need the advice of those who perhaps have had experience in some particular line. I do not quite understand how we may obtain the benefit of the experience of all the members of the Association unless we bring the subjects to a vote, or obtain an expression from each individual. The Committee may consider a subject, such as has been referred to, and the chairman, after consulting with the members of the Committee, will present a type, not a standard, and it is barely possible that the Committee is not quite able to arrive at the correct solution of the question. It is barely possible that there are other members in the Association who might contribute something and influence the adoption of the type. How are we to arrive at the opinion of the Association as a whole if we only accept the Committee's report, and take no further action in the way of indorsing or rejecting it as an organization?

I was very much interested in a certain subject a short time ago, and sent for the proceedings of a certain association and read them very carefully, but I did not learn what the sense of the whole organization was. If we can arrive at that understanding in our meetings, then we may present the ruling type—that is, the type of the whole organization.

The President:—In answer to Mr. Lum's remark, I might say that the idea that the Board of Direction had in mind in reference to that was this: That after we got a little farther along, and we have derived more information from the reports of our various committees, that then the time will come for us to take action as an Association and determine the policy of the Association, and formulate the conclusions of the Association; that the idea of this first meeting was simply to have an interchange of views between the different committees and the individual members of the Association. If, at the close of the discussion of all the reports, it is thought wise by the members of the Association, or any of them, to make a motion or pass a resolution outlining the sense of the Association as to how the committee-work should be handled, or what the policy of the Association should be in reference to the consideration of the work, then it will be the proper thing to do; but it was not

our idea to take action of that kind until we had heard the reports of all the committees and they had all been discussed. You can very well see that without that our work must consist, first, in the acquisition of knowledge; second, in the assimilation of that knowledge, and, third, in the formulation of our conclusions from it.

If there are no further remarks we will consider the usual motion passed in reference to this Committee, and excuse them temporarily.

The Committee on Masonry will please come forward.

Mr. W. L. Breckinridge, Chief Engineer Chicago, Burlington & Quincy, chairman of the Committee on Masonry, presented the following report:

REPORT OF COMMITTEE VIII.—ON MASONRY.

To the American Railway Engineering and Maintenance-of-Way Association:

The subject of railroad masonry, differing from others coming under the consideration of the Association in being less general and influenced by local conditions, can only be treated specifically when applied to the needs of a limited territory. For this reason I should have, perhaps, consulted with the members of the Committee to obtain their views, instead of submitting an individual opinion, but not having the opportunity to do so, I will state the manner in which I think it should be taken up.

The outline as recommended, as furnished by the Society, is satisfactory, and will probably be followed. I suppose it was the intention to include material of construction as well as design and practice, and therefore I would change the heading of paragraph six from "Concrete Masonry" to "Materials." The question of materials being now in a state of transition, needs much consideration. Brick and concrete rank equally with stone, especially in parts of the country where the natural product is not near at hand, or of an inferior quality. To include materials will permit covering important preparatory ground, aside from design and construction, giving an opportunity to define the various classifications; also to obtain a uniformity of descriptive terms and to prepare standard specifications for different localities.

The subdivision of design and practice, as outlined, I would follow, except under the head of culverts; paragraph three should include four and five, subdividing it into masonry, iron pipe and wood. It may be advisable to add other general masonry construction-work required in railroad practice.

In preparing a report for the next meeting I had in mind the recommendation in Circular No. 8, not to endeavor to cover the whole subject. I suggest that we should take up the most important questions

of the day, which would be of greatest value and immediate benefit to ourselves and the railroad companies, and I expect to ascertain from members of the Association on what points information is desired.

The question that first occurs to me is about concrete specifications and practice. The company that I represent has gone into this work on a large scale. We have followed certain general lines in the construction, but have not prepared any specifications that might be called standard. Cast-iron pipe is another item in our bills of material. The high price may limit its use, and there may be something that can be used as a substitute.

Other subjects will be taken up as the Association requests, and considered in order of their importance. This is in line with paragraph three of Circular No. 8, and is my view of the manner in which we should proceed.

The recommended subdivisions would be tabulated as follows:

Masonry: Materials—stone, concrete, brick.
Design and Construction: Bridge—arch.
Culverts and Small Waterways: Masonry, iron, wood.

W. L. Breckinridge, Chief Engineer Chicago, Burlington & Quincy, Chicago, Chairman;
E. P. Dawley, Division Engineer New York, New Haven & Hartford, Boston, Vice-Chairman;
William Hood, Chief Engineer Southern Pacific Company, San Francisco, Cal.;
H. G. Kelley, Chief Engineer Minneapolis & St. Louis, Minneapolis, Minn.;
W. E. Hoyt, Consulting Engineer, Rochester, N. Y.;
F. S. Stevens, Division Engineer Philadelphia & Reading, Reading, Pa.;
C. F. W. Felt, Chief Engineer Gulf, Colorado & Santa Fe, Galveston, Texas;
B. T. Fendall, City Engineer, Baltimore, Md.;
F. M. Bisbee, Chief Engineer St. Louis & San Francisco, Springfield, Mo.;

Committee.

The President:—I think that one idea the Committee ought to consider is that of definition. It was not very long ago that the road I am connected with was interested in a piece of construction-work in which they were required by a city ordinance to construct a wall of masonry, and the question was whether concrete was masonry, whether brickwork was masonry, or whether masonry, in order to define it, should be called stone-masonry, brick-masonry or concrete-masonry.

I believe the same question came up at one time in reference to the legality of the bridge bonds of a bridge near New York City, in which a trust company did not want to take the

bonds because the company proposed to construct the piers of concrete, when the act under which the bridge was to be constructed specified that they should be of masonry. I simply throw this out as a suggestion in the discussion on this Committee report.

Mr. A. Torrey, Chief Engineer Michigan Central:—I believe the Constitution provides that we do not want to enter into the discussion of patented articles, and I would like to ask how far that principle can be observed. Of course, there are several kinds of patents that may prove very useful. That may hardly apply to masonry, perhaps, but the thought occurred to me how far the Committee intend to go in the investigation of any patents to be presented to the Association.

The President:—I think that is a matter for the Association to decide. I do not see how we can avoid the consideration of patented articles.

I do not think, speaking simply as an individual, that we ought to be restricted, whether an article or process is patented or not, provided it has merit.

There is one line of investigation that ought to be gone into by the Committee, and that is, in the first place, the economy of masonry and permanent structures of masonry, as against temporary structures; and, secondly, the relative economy of different forms of masonry, such as stone or concrete, or brick, and so on in relation to localities. In some parts of our country different forms of stone masonry are more economical; in other parts concrete is more economical. But the question should be considered, it seems to me, from the standpoint of economy.

Mr. C. E. Lindsay, Roadmaster Southern Railway:—The question of the proper size of culverts for a given drainage area, or a given topographical condition, is one that could well be studied. I think the text-books even are not very clear on the subject.

Mr. R. C. Barnard, Engineer Maintenance-of-Way Pennsylvania Lines West:—There is one thing that I think should be considered in connection with this report, which will apply with equal force to the work of the other committees, and that is the matter of submission to the Association of plans for proposed standards. The members of each committee can easily prepare plans for their own use, but to receive the sanction of the Association they should be examined by each member of it,

so that an intelligent opinion can be had of the subject under discussion before the members are called upon to vote their approval of it. If this is not done before the regular meetings of the Association, a great deal of time will be consumed at the meeting going over the plans in detail. I ask for information as to how it is proposed to handle this matter.

The President:—It has been the policy of the Board in reference to this meeting, and for future meetings of the Association—unless that is modified by some action which the Association may take a little later on—to have these reports sent in far enough ahead so that they can be printed and distributed among the members, in order that you may have a chance to carefully consider the points you want to raise long enough before the meeting so they can be well considered. I would like to remark here that a little later on in the order of our business, after we are through the consideration of these reports of the standing committees, and when we come to the order of New Business, it will then be proper for any member of the Association to bring any motion or introduce any resolution that he may see fit in regard to the policy of the Association-work.

Mr. S. P. Hutchinson, Asst. Gen. Agent Pennsylvania Railroad:—Under the head of culverts and small waterways I think it is worthy the attention of the Committee to look into the subject of the best distribution of the area that has been decided on for the stone-arched culvert. It is generally conceded that a low, wide opening will carry a stream better than a high, narrow one, and in the work I was on we found that with a very slight additional expenditure of money we got better openings by building segmental arches, with low bench-walls, rather than semi-circular arches with higher bench-walls.

The President:—We have a gentleman here who has a very long line of railroad in a very cold country, and where masonry has to stand up against frost more than anywhere else, and that is Mr. Peterson, of the Canadian Pacific.

Mr. P. A. Peterson, Chief Engineer Canadian Pacific:—In recent years we have built on the line of the Canadian Pacific Railway a great many masonry arches, retaining walls, etc. We find that there is great economy in building flat segmental arches, making them as wide as necessary and only as high

as is required to pass the stream, floating logs, stumps, etc., and in every case where we are preparing to double-track our line, we have put in arches of rubble masonry up to 60-foot spans with great economy, compared with the cost of abutments and steel girders. This kind of work, laid in the best Portland cement, costs about $6 a yard, and this we find is cheaper than concrete, as it takes much less cement, which becomes very expensive when it has to be hauled from fifteen hundred to two thousand miles.

Where our line runs along the Fraser River, we have walls one hundred feet high and large arches built of rubble masonry, using as large stones as can be conveniently obtained, and filling in between the interstices with still smaller stones mixed with Portland-cement mortar and very small stones, so as to make a thoroughly solid mass. We have found that this method, when intelligently carried out, makes the cheapest masonry, as less than one-half of the cement is used in this that is required for ordinary masonry or for concrete. Intelligent Italians, experienced in building roads in Italy, have been found to do this work cheaper than any other class of labor. The only cut stone used in this character of work is the bottom bed of the coping and the outer rings of the arches, and when the work is carefully pointed and the coping neatly pitched, it looks, in my opinion, quite as well as the best cut-stone work, and, in most places, very much better, as it is more in harmony with surroundings and shows evidence of economy.

In many cases we have used cedar in the construction of small box culverts. We find that cedar grown in British Columbia has a life of nearly two hundred years. I have in my office samples of sound cedar cut from a log found in Vancouver Park, Vancouver, British Columbia, which has growing over it a spruce measuring thirteen feet six inches in circumference, twelve feet six inches above the ground. Adjacent trees that have been cut down of the same dimensions as this spruce show 192 rings; so this cedar, from which the sound samples were taken, must have been lying in its present position more than 192 years.

Mr. W. E. Dauchy, Chief Engineer Chicago, Rock Island & Pacific:—In speaking of the subject of using stones imbedded in concrete brings out the question of the desirability of the

homogeneousness of concrete work. We are all more or less getting into concrete, and I think the question of using the same character of material all the way through should be considered. Now, I think it is frequently the practice to use different kinds of cement in the same structure, facing with Portland cement, perhaps, and using a backing of cheaper cement. There is also the question of imbedding larger rock in concrete—whether it is a desirable practice to carry out.

Mr. Hunter McDonald, Chief Engineer Nashville, Chattanooga & St. Louis:—There is another question I would like to submit to the Committee for consideration, and that is the load that goes on a culvert from an embankment. In determining the kind of foundation, which should be established, and also the size of the walls, it becomes necessary to determine the load that that culvert is to carry. I find a great difference of opinion as to the manner in which the load is transmitted to the culvert by the embankment, and also the rolling load, and I would like very much to have the Committee consider that point and submit it to the Association for further discussion.

Mr. W. G. Curtis, Engineer Maintenance-of-Way Southern Pacific:—In regard to the use of large stone in concrete, I have been familiar with that practice for a number of years. We have practiced that and we have had no failure. It is our practice to build masonry in large masses with the concrete, because, as a rule, it is a cheaper form of structure. It is our rule, and our printed specifications require large pieces of stone to be incorporated in the mass, care being taken that these large stones be perfectly sound, and, good cement used, in general, we have seen no reasons why we should take these large sound stones and break them up into small pieces, merely to cement them together again.

Mr. Dauchy:—Perhaps I stated too generally what my idea was. I have followed the practice the gentleman cites to a certain extent, but I think if we could have some experiments to show the strength of different characters of concrete, where it is homogeneous and where it is not, and get the relative value and strength of material in that way, the information would be of great value.

The President:—If there is no further discussion, we will excuse the Committee on the usual conditions.

As the Governor of North Carolina said to the Governor of South Carolina, "It is a long time between drinks"—we will call on the Committee on Water Service.

I have the pleasure, gentlemen, of introducing Mr. W. E. Dauchy, the chairman of this Committee.

Mr. Dauchy presented the following report:

REPORT OF COMMITTEE XIII.—ON WATER SERVICE.

To the American Railway Engineering and Maintenance-of-Way Association:

The amount of water used by railroads of the United States during any year is enormous. Estimated in dollars and cents, it represents many millions of dollars. Just how many it is difficult to say, as the systems of accounting now in vogue on most roads distribute this expenditure among the various accounts and do not show it in figures by itself.

The cost per gallon of the water used by the different roads would, perhaps, show a larger variation in figures than the cost of any other article consumed in the operation of railroads. If the cost per gallon of the water furnished by each individual plant of all the roads in the country could be obtained, it would, no doubt, furnish a very interesting study.

Under the head of "Water Service" the Board of Direction has outlined the subject under three general heads:

First—The source of supply.

Second—Method of pumping and supply.

Third—Character of water.

In outlining the work of the Committee, these three divisions seem to be the natural ones to follow, and each will be considered briefly.

First—The source of supply.

This is a comparatively simple question when the character of the country is such that there is an abundance of water to be had, and the only things to be considered in such favored localities are the selection of the water best adapted to boiler use, and the cheapest method of obtaining it. But the rapidity with which this question becomes a complex one is, perhaps, best appreciated by those of our members who have had to deal with the arid and semi-arid regions of the West and Southwest.

In some portions of these arid districts the question of obtaining suitable water at any cost is very much of a problem. In other portions there is water to be had at a reasonable cost, if one has the good fortune to find it; but in the search for it the element of chance sometimes enters more largely than engineering skill. As an illustration of what is meant I will cite two instances.

The first occurred in Eastern Colorado, where, in selecting the location of a water station, the only apparent source of supply for a distance of twenty miles along the line of road was a small spring, situ-

ated about a mile from the track, on a slope which inclined toward the railroad. The spring furnished but a small supply of water, which soon lost itself in the sand in the bottom of a dry stream, which crossed the track where the water station was located. A well was dug alongside the stream and so located that it caught all of the drainage from the stream due to rainfall. For several years this supply was made to answer the requirements by careful usage, but at times it failed entirely. In the meantime, test wells had been put down at all promising places in the vicinity, without finding any water, until one day a test well was dug upon the top of a ridge, about three hundred feet from where the original well was located, when a vein was struck which has furnished an abundant supply ever since.

The second case occurred in the Indian Territory, at a division station. There was plenty of water to be had in a flowing stream, but it was of a very bad quality for boiler uses. Numerous wells had been dug and drilled in the vicinity, varying in depth from 50 to 900 feet. In the deep well a fine flow of salt water was obtained, but the other holes furnished little or no water. But the Superintendent of Water Service, like the persistent mole, kept burrowing in the ground until he was rewarded by striking a fine flow of good water in a gravel strata, eight feet thick, that was situated in the very midst of his other futile attempts.

I cite these instances merely to show that a large amount of money might have been saved if there had been some means of knowing where to look for underground water. Now, I do not know that any amount of investigation would entirely remove this element of chance in the search for underground water, but I think that the work of the Committee under this division of the subject should be largely devoted to obtaining all of the information possible with regard to the location of underground water and its relations to different soils and different strata of rock. This would apply, perhaps, more particularly to deep wells.

As a rule, it is a difficult matter to find out much about a drilled well, except as to the amount and character of the water that it furnishes. In a majority of cases no record is kept of the different strata that the well has penetrated, and if, as is often the case, the well has turned out to be a dry hole, its existence is soon forgotten.

If a systematic record could be kept of all deep wells that are put down, showing the location, general character of the country, the strata penetrated, and if water is obtained, in what stratum, or between what strata it is found, a record of that fact made, the information obtained in that way would be of value as a guide to future operations.

For instance, it is one of the most uncertain things to determine, in the search for water in deep wells, when to stop drilling. Now, if the records kept in a large number of wells should show that under certain strata of rock, or combination of strata, no water had been found, when the drill had reached these same strata, it would be policy to stop; or if in a number of wells salt water had been found, and in no case had good water been found under the salt water, the reaching of salt water would be an indication of the uselessness of a further expenditure of money upon that hole.

I think this question as to when to stop drilling is one of the hardest things to decide in the putting down of deep wells. A large amount of money has perhaps been spent with no favorable result, and the question is whether to keep on a little longer, in the hope of obtaining good water, or to stop short; and this continual keeping-on finally amounts to a large sum of money, so that if we could have the advantage of the combined experience of all, I have no doubt it would be the means of saving large sums of money in useless drilling. But this is merely the negative side of the question.

If the same records of holes drilled could give us some indication as to where, in the general configuration of the country, a search for water was likely to be successful, still more favorable results would be accomplished.

Almost every person who has had experience in putting down wells has a theory of his own as to where water is to be found, and these theories vary in value from that of the man who believes in the divining power of a witch-hazel bough to that of the engineer who bases his theory upon accurate records of a large number of both successful and unsuccessful holes, and probably the experience of each would add something to the value of the combined knowledge, and I think it should be the effort of the Committee to get the result of this combined experience in the shape of records of both past and future work.

It frequently happens that the supply of water in drilled wells may be increased by the use of explosives to open the seams of the rock at the bottom of the well. Information as to the kind of explosives to use and the best method of handling them would be of use.

In open wells the amount of water to be obtained may sometimes be increased by running tunnels out in different directions from the bottom of the well, or by connecting two or more wells together by tunnels. This should be considered, and, in general, the different methods of drilling and casing drilled wells and of sinking open wells should be investigated.

Second—Method of pumping and supply.

Under this head should be considered the location of water stations.

In selecting such locations the questions of convenience, minimum delay, safety of trains and economy should be considered.

On very busy lines facilities for taking water should be located at regular stations, while on lines where traffic is light it is sometimes advisable to locate tanks between stations as a matter of economy; but whenever they are so located the question of grades and of protection to trains should be considered.

As to the different methods of supplying water directly from tanks, or through water columns, or track tanks, the desirability of each method should be considered, in connection with the amount of traffic, the minimum delay to trains and the question of economy. The comparative cost of each method should be determined as nearly as possible.

Under the head of pumping, I think a thorough investigation of the

circumstances where windmills can be used to advantage should be made, and also a complete investigation of the relative cost of the use of gasoline engines for pumping purposes, as compared with steam-pumps.

A great many gasoline pumping plants have been established during the past few years, but owing to the rapid rise in the price of gasoline some of them have been discontinued and pumping by steam substituted.

Steam-pumping machinery has reached such a degree of efficiency that I do not know that anything need be said with reference to that.

Third—Character of water.

I do not know that much need be said at the present time under this heading. We all know what bad water is, and that a great deal of it is used daily by many roads in the country. Water that the chemist pronounces totally unfit or very bad for boiler use is nevertheless used for the want of something better, and, in a way, serves its purpose in getting trains over the road, probably at a large expenditure for new flues and boiler repairs.

It would be interesting to know, if the figures were obtainable, just the amount of money that is expended upon boiler renewals and repairs that is due to poor water, but after we had obtained the figures I do not know that they would be of any great service otherwise than to satisfy our curiosity, or, perhaps, be an incentive to the inventor of boiler compounds, as, in most cases, poor water is used because no better is to be obtained.

There are, no doubt, many instances where poor water is used because of the necessity of a large expenditure of money to obtain good water, but each case of that kind must be considered upon its merits, being merely a comparison of the saving in boiler repairs, with the annual interest charge upon the amount necessary to be expended to obtain good water.

An investigation of the efficiency and cost of compounds to counteract the impurities of water would be very beneficial, and the investigation should include the different kinds of chemical filters.

Under this division of the subject might also be considered the question of repeatedly using a portion of the water that is used around roundhouses and shops. At division stations a larger amount of water is usually used for washing out boilers and other purposes than is used for making steam, and where water is scarce, a large saving can be effected by constructing cisterns to catch the water used for boiler washing, and the same water can be used again and again for that purpose. Sometimes it is desirable to run this water through a filter; at other times this may not be necessary.

There are probably other questions of interest in connection with water service that the Committee will find it profitable to investigate that have not been touched upon, and I have merely outlined a few of what have seemed to me the most important.

W. E. Dauchy, Chief Engineer Chicago, Rock Island & Pacific, Chicago, Chairman;

D. Willard, Assistant General Manager Baltimore & Ohio, Baltimore, Vice-Chairman;
H. C. Draper, Consulting Engineer Chicago & Alton, Chicago;
O. D. Richards, Chief Engineer Ann Arbor Railroad, Toledo, Ohio;
W. B. Storey, Jr., Engineer and General Superintendent San Francisco & San Joaquin Valley, San Francisco;
G. H. Webster, Engineer Maintenance-of-Way Manitoba & Northwestern, Winnipeg, Man.;
Samuel Rockwell, Principal Assistant Engineer Lake Shore & Michigan Southern Railway, Cleveland, Ohio;

Committee.

The President:—Water supply is getting to be more and more important for us all. When we used to run small and light trains it was not a very serious matter, but for years our tonnage has been increasing and water consumption increases. On roads that up to a few years ago there was little trouble, the water supply now has become a very serious question. The subject is now open for discussion.

Mr. T. F. Whittelsey, General Superintendent Toledo & Ohio Central:—In various parts of the country water supply is very much impaired by operations of mining and the production of oil, and a large amount of salt water is pumped into streams, deteriorating the natural water to a large extent. I think it would be well for the Committee to consider the practicability and cost of securing for locomotives practically pure water by some system of filtration. I think we will have no permanent results in preventing scale on the boilers until we put nothing but pure water into the engine tanks.

Mr. W. G. Curtis, Engineer Maintenance-of-Way Southern Pacific:—The Committee has presented us with a very excellent report, and I can think of nothing in the way of suggestion in addition to the lines of procedure that they have marked out for themselves. On the line in which I am interested, the water problem is a serious one. We run through a large extent of country—in some places below the sea level, and at other places having mountain elevation. We have no method of telling where underground water is to be found, and find it more or less by accident. We find a good well at one place, a long distance away we will find another, and, then, boring at short intervals, we endeavor to locate intermediate wells.

Years ago, on a wagon road across a desert—a supposed desert—water had to be hauled for the supply of a stage sta-

tion. When our railroad was under construction there, and water was being hauled to the end of the track and beyond the end of the track in carts for the supply of the Chinese laborers, the riding boss came along one day and found a hole in the ground full of water. He immediately got off and whipped the Chinaman nearest to the hole, and fortunately after awhile the Chinaman recovered sufficiently to say that that was natural water and he had developed it himself. This surface water was found unsuitable for steam uses and we sunk some deep wells at random, finally getting a flowing or artesian well that gave 80,000 gallons a day. We sunk one well as deep as 2,600 feet, and finally losing the boring tools in the bottom, abandoned it—a dry hole. Experience in Arizona and New Mexico, I think, has disproved all our reasoning as to where water could be found, and about all the good wells we have were found by accident. We bored one well five hundred feet deep in a desert depression below the sea level which discharges an excellent quality of water over the top of an ordinary tank.

We are treating a good many of our waters by scientific method, and we have got a good deal of good water by threatening to treat bad water. When we threaten to treat bad water, our division people go to work and find good wells. We don't believe much in mysterious panaceas for treating waters. They are a good deal like the man down in Texas who gave pills to everybody who was sick; no matter what was the trouble, he always gave them the same pills. But in the matter of finding water, we have tried many methods. We have tried the witch-hazel man and the man with the mysterious electrical contrivance, and other things, until we have come to the conclusion that the finding of underground water is to a great extent a matter of chance.

Mr. C. A. Wilson, Chief Engineer Cincinnati, Hamilton & Dayton:—I think that one of the most important features in this water supply is the question of water treatment. From some investigations I have recently made I have come to the same conclusion that Mr. Whittelsey has—that wherever bad water existed, a good surface supply could not be obtained. Where a good surface supply cannot be obtained, I believe that there is no question but that the water treatment would amply

repay for its cost in the washing of the boilers alone, which now, in my opinion, costs more than it costs to treat the water.

I want to call the attention of the members to the report of the Master Mechanics' Association on this subject for the past year—1899—which many of us might find to be of use.

The President:—There is one thing in the water service that has not been touched upon in the subhead under the committee-work, and that is the question of organization—that is, how the water service should be handled on the different railways. I believe it is the custom on some systems to have that under the maintenance-of-way department, and with others to have it under the machinery department, and I think it is a matter that the Committee ought to consider.

Mr. Dauchy:—Wouldn't that come under the work of the Committee on Organization, if there is such a committee?

The President:—Yes, there is such a committee. Still, I think that each of the committees should take up the question of organization in so far as it affects its own committee-work, in addition to its general treatment by the Organization Committee. It would, of course, be the proper thing for the Committee on Organization to keep in touch with the committees on the various other subjects and get their ideas as to how the organization of their particular work should be treated.

On the Illinois Central Railroad the water supply is handled primarily by the division officers, the division superintendents being considered general managers, in fact, of their division. In order, however, to have the water supply of the entire system properly handled and the different divisions supplemented in their efforts, the matter is under the Chief Engineer, who has charge of maintenance-of-way matters, and he has a staff officer, whom we call the general foreman of water supply, whose business it is to study the water question of the entire system, and to confer, advise and consult with the division officers as to the problems on their respective divisions with regard to the water supply, quantity and quality, and the proper machinery to be used, etc.

This general foreman of water supply is also equipped with a diamond drill and with various mechanisms for deep-well experiments, and the sinking of deep wells on the entire system is under his control. This outfit is kept moving from one place

to another, and when there is no actual work for it, it is used for experimental purposes.

Mr. W. D. Pence, Professor of Civil Engineering, Purdue University:—The question of the tank itself would, it seems to me, come more properly under the head of water supply than under that of structure. I see in the outline of the report that the water tank is mentioned under the head of building or structure.

Would it not be well for this Committee on Water Supply to discuss the material of which the tank is made? This is a very live topic in some portions of the country; for example, a white-pine tank, which would give excellent service in a northern climate, would have a very much shorter life in the South.

Likewise the question of the use of metal tanks. That question is receiving a great deal of interest, and with the metal market in anything like a normal condition, the use of metal tanks would be the cheapest.

I would like to hear the experience of some of the roads on which the metal tanks have been used—I think the Rock Island has used them.

Mr. Dauchy:—I can say that we have put up quite a good many metal tanks during the past three or four years, and we considered them a great economy up to the rise in the price of steel, and I don't know but they are at the present time.

Then there is another question in regard to the metal tank. You can usually get a tank of larger capacity, and that very frequently saves the cost of the tank in the pumping service. Take a station where a large amount of water is usually consumed, it generally has to have both a day and a night pumper, and we have in a number of instances put up these metal tanks, or standpipes, as they are sometimes called, and we have saved the cost of one pumper—about six hundred dollars a year.

The President:—There are a great many of these subjects where one committee or another can discuss it, and in those cases both committees should look into it, and should communicate with the committee that has the same subject to consider, so that there will be some harmony among them.

Mr. C. E. Lindsay, Roadmaster Southern Railway:—The report speaks particularly about going down for water. I hope they will not forget to go up for it and appreciate the value of

the gravity supply. There is, too, to be considered the economical ratio of the value of the land covered, and the cost of the dam to the cost of the water from a gravity supply. In our youth we perhaps have sung the virtues of the Derby ram, and I hope the Committee will investigate the hydraulic ram and see if there are any virtues in it they may extol.

The President:—It is now five minutes to two o'clock. I am very sorry to stop this interesting discussion. Out of the fourteen committees we have full reports from all but three, and two of these three we expect to have to-morrow, so that we will have eight committees to hear from at that time. As near as we can judge, it will require about four hours' continuous work, and it is a question whether we should hold one continuous session, or whether we should convene at ten o'clock, as usual, and have a recess, say, from 12:30 to 1 o'clock, and have a session in the afternoon, closing that session in time for preparation for the banquet.

I would like to hear some discussion from members of the Association as to what we should do in reference to the programme to-morrow, as to whether we should hold one continuous session or two sessions.

Mr. Sullivan:—I think that question can safely be left until to-morrow. If you are making good progress in the consideration of the reports, and it is found that by remaining an hour longer the business can be closed up at one session, I believe that to be the most desirable arrangement to make; but if the work is consuming time to such an extent that one session is impracticable, that question could be determined at the usual time for taking a recess, and then arrangements could be made for two sessions, with a recess for lunch.

The President:—If there is no objection, we will handle the matter as suggested. I think Mr. Sullivan's idea is a good one, but I would like to have you come to-morrow prepared to hold a continued session, or to give up your time in the afternoon, if possible, to our Association-work.

The interest and importance of these reports seem to me to be such that we should not adjourn our annual meeting until we have gone through them all thoroughly. At our next meeting we will be better prepared to determine the length of time it will take to consider these matters.

To-morrow is the annual election of officers, and the announcement of the result is the last thing on our programme. I will appoint C. A. Wilson, E. C. Macy, and C. Dougherty as tellers. The polls are closed at this session. These gentlemen will call upon the Secretary, who will turn the ballots over to them, and they will count them and have their report ready at the close of the meeting to-morrow.

Has the Entertainment Committee anything to announce?

Mr. C. W. Hotchkiss, of the Entertainment Committee:— The train will be back here at 7 o'clock to-night. It will leave at 2:30, and we will have about thirty minutes to adjourn and get to the Dearborn-Street Station.

On motion, the meeting adjourned, to meet Thursday at 10 o'clock.

THURSDAY, MARCH 15, 1900.

MORNING SESSION.

The President:—At the meeting of the Board of Direction last night the transactions of the Association up to the close of this First Annual Meeting were ordered printed by the Publication Committee. It will make a book about the size of these leaflets, about an inch and a quarter to an inch and a half thick. It will be quite a volume and will be ready for distribution among the members about the first of June. The members will be notified by the Secretary that they can have their choice of those transactions bound in paper without any expense, or bound in cloth or half-morocco at the cost of binding.

In those transactions will be printed a list of charter members, as revised to date. The former list, printed in December, was found incomplete. Some members whose application came in under the order of the Board of Direction as charter members did not reach the Secretary until after that date, and it was finally decided to revise that list and to print as charter members all of the members that have been admitted to the Association up to this, the First Annual Meeting, which we have chosen to regard as our real first meeting.

At the noon recess—whether it be long or short—the chairmen of the various committees would like to have short sessions of their committees. Several of these chairmen, or vice-chairmen, have spoken to me and stated they were not familiar enough with the membership of their committee to be certain of finding them, and it was thought easier for the committees to find their chairmen or vice-chairmen; so you will kindly group yourselves at the noon recess, or immediately at the close of the session, so the chairmen or vice-chairmen can have at least a word with their committees before they go. I think you will find it of advantage in your committee-work.

The Secretary:—In regard to the banquet to-night, it is necessary, in order that each member may have his proper place assigned at the table, that cards be secured in the ante-room here

during the recess. The tickets will be ready for you there, and you will pay for them at the time you get them. The ticket has a number corresponding to the seat at the table. If any of you fail to get tickets here this morning, or during the recess, you can get them at the Victoria Hotel between three and six o'clock this afternoon.

The President:—At the close of our meeting yesterday we were so anxious not to delay the Santa Fe train that we left the Committee on Water Supply, as you might say, hanging in the air. We did not receive their report, and we did not thank them, and I know we fully appreciate Mr. Dauchy's report and the work of the Committee. If there is no objection on the part of the Association, the Committee can consider themselves thanked.

We have a great deal of work, gentlemen, before us to-day, and I hope you will excuse me if we lay aside all parliamentary frills and get down to business and carry it through energetically.

Mr. Dauchy:—We appreciate the thanks of the Association very much. We thought we did not have a dry subject, by any means, and are glad to be treated like the rest of the committees.

The President:—The Committee on Ties will please come forward.

The Secretary read the names of the Committee.

The President:—I beg that Committee's pardon. I presumed the Committee was ready. We will call another committee—the Committee on Interlocking.

The Secretary then called the Committee, who came forward.

The President:—I take pleasure in introducing Mr. Miles, Signal Engineer of the Michigan Central Railroad, who will read his report.

Mr. H. D. Miles, chairman of the Committee, submitted the following report:

REPORT OF COMMITTEE X.—ON SIGNALING AND INTERLOCKING PLANTS.

To the American Railway Engineering and Maintenance-of-Way Association:

The Committee on Signaling herewith presents a brief outline of the topics to be treated under the headings given in the pamphlet issued by the Association.

It has not included most of those subjects which have been considered and acted upon by the American Railway Association. It would not seem necessary or advisable to treat of exclusively operating questions in relation to signaling, when those questions have been so fully considered by a special committee of the American Railway Association and acted upon by that association.

The Committee assumes that the American Railway Engineering and Maintenance-of-Way Association will deal with engineering and maintenance matters principally, and consider operating questions only in so far as they affect, or are affected, by the engineering and maintenance problems. This is a question, however, which must be decided by the Association, and the Committee therefore desires to be instructed.

As the membership of the Committee is small, and each general subject will require a large amount of work in order to be treated properly, it has been deemed advisable to consider but one subject at a time, and as the large majority of interlocking plants are jointly owned, operated and controlled by two or more companies, it is evidently the subject which should be considered first. The Signal Committee should consult with the Committee on Track in regard to the design of switch-rods, the spacing of such rods, the bracing of stock rails, the use of gauge plates, etc., and should consult with the Yard and Terminal Committee regarding the location of switches, frogs and connections for convenient and safe manipulation when handled by interlocking plants.

It is proposed to standardize, as far as possible, the specifications regarding the construction of mechanical interlocking plants, and the designs of material which enter into the construction of such plants. It is also proposed to standardize, as far as possible, the specifications regarding the design of block and train-order signals, and the specifications covering the installation of automatic block signals. The requirements necessary in the matter of circuit designs, which are employed in automatic block signaling in order to insure safe operation, will be fully considered, as will also the question of proper indications to be given of the position of interlocked switches and signals which are operated in connection with power plants.

1. Signals:
   - (*a*) Train-order Signals:
     - Most desirable type.
     - Usual location.
     - Drawings, showing standard design of post and fittings and operating levers and connections.
   - (*b*) Distant Signals:
     - Their use as caution signals for train-order signals, station block signals, automatic block signals and interlocking high-speed home signals.
     - Most desirable forms.
     - Maximum and minimum distance from home signal.
     - Most desirable form of operating connections.

Drawings of standard design of posts and fittings for mechanically operated signals.

Circuit-controlling arrangement for those electrically operated.

(*c*) 1. Block Signals: Manually operated—telegraph communications between stations:

Most desirable form.

Usual location.

Drawings of standard design of post and fittings and operating levers and connections.

(*c*) 2. Block Signals: Manually operated and electrically controlled:

Most desirable form.

Usual location.

Drawings of standard designs of posts and fittings and operating levers and connections.

Description (and possibly drawings of circuits), giving requirements necessary for accurate information between operators and safe operation of signals.

Specifications governing construction.

(*c*) 3. Block Signals: Automatic:

Most desirable form.

Normal danger or normal clear system.

Distant signals, or overlaps, visible or audible switch indicators.

Protection against lightning troubles.

Designs of circuits to cover usual conditions at stations, yards and between stations both for single and double track, and location of signals to cover such usual conditions, taking into consideration grades, curves and volume of traffic.

Specifications governing construction.

2. Interlocking Plants:

Railway crossings and drawbridge protection, arrangement and location of derails, locks and signals.

Arrangement of tracks, and switch and frog connections, and the location of signals most suitable for the safe and rapid handling of traffic in yards.

Standard specifications regarding the quality and type of material to be used, the arrangement and location of facing point and bolt locks, and the requirements generally covering the construction of plants.

Drawings of standard designs of apparatus used in the construction of plants which are likely to be adopted as standard by a majority of roads.

Under what conditions are power plants desirable.

Desirability of electric locking and the question of a time release as a substitute.

3. Highway-crossing Signals:
   Gates.
   Drawings, showing design of gates and operating connections.
   Alarm bells.
   Most desirable types for the several conditions to be covered.
   Modes of operation.
   Lettering on sign for alarm bell.
   Specifications governing construction.
4. Miscellaneous questions:
   Flag-station signals.
   Fixed signals for protecting trains at isolated points.
   Signals connected with isolated switches.
   Colors for night signals.

H. D. MILES, Signal Engineer Michigan Central Railroad, Detroit, Mich., Chairman;
F. W. SCARBOROUGH, Engineer Bridges and Signals Chesapeake & Ohio, Richmond, Va., Vice-Chairman;
W. J. GILLINGHAM, Jr., Signal Engineer Illinois Central, Chicago;
J. S. HOBSON, Signal Engineer Atchison, Topeka & Santa Fe Railway, Topeka, Kan.;
A. H. SANFORD, Engineer Maintenance-of-Way Pennsylvania Lines West, Toledo, Ohio;

Committee.

After reading the report, Mr. Miles proceeded as follows:

Mr. Miles:—According to the present method of signaling in vogue in the United States and in the countries contiguous to it there are several types of signals used for the same purpose, and I therefore think the Association should endeavor to adopt, as far as possible, standard designs of signals for the various uses to which signals are put, and to have as few designs as possible.

The Committee will require a great deal of information from the several roads represented in this Association, and I would ask that the members of the Association aid the Committee as much as possible in obtaining plans, rules and general information regarding signaling in connection with the roads which they represent.

The President:—The question is now open. If any of you have anything to say on this subject, speak up, and let us get some action on it.

I am afraid, however, that we have made one mistake, in that we have probably the majority of our members who are conversant with interlocking signals on this Committee.

Mr. Richards, have you anything to say?

Mr. Richards indicated that he had nothing to say.

The President:—Mr. Hutchinson, have you anything to say?

Mr. S. P. Hutchinson, Asst. Gen. Agent Pennsylvania Railroad:—Mr. President, all I can say is that I believe the Committee has very thoroughly covered the ground to be looked into. Mr. Shober, here on my left, suggested one thing that it may be well to look into in connection with this subject, and that is, drawbridge signals. I don't see that in the list.

Mr. Miles:—I think you will find that is included in the report of this Committee.

Mr. Hutchinson:—Well, then, I don't think of anything I can say. The report seems to bring the subject out very fully and clearly to me.

The President:—Mr. Sullivan, can you throw any light on the question, or have you any questions you would like to ask the Committee?

Mr. Sullivan, General Superintendent Illinois Central:—I think the Committee's scheme is quite a complete one. There is one thing more, however, that might be considered, and that is the combination of audible and visible signals for use in tunnels or places where visible signs are likely to be obscured, so that the audible signals may serve to supplement the visible signals as an additional safeguard.

The scheme of the Committee is quite comprehensive, and there is very little to be said in addition to what they have submitted.

The President:—Mr. Dwight C. Morgan is here and is one of our guests, and he expects to be one of our members. He was Consulting Engineer of the Board of Railway Commissioners for the State of Illinois, and I think he could throw some light on the question, if he will.

Mr. Dwight C. Morgan, Engineer Maintenance-of-Way Chicago & Alton:—I think the scheme submitted by the Committee is a very complete one, and I do not believe I can offer any suggestions that would improve the plan presented.

What I wish to say in respect to interlocking is somewhat out of line so far as the report of this Committee is concerned, but it may come within the scope of this Association. As a

usual thing, the least item to be considered in equipping a grade crossing with interlocking is the first cost of installing the plant. Take, for example, a simple crossing requiring twelve working levers; the cost is approximately $225 per lever, or $2,700 completed and ready for operation. The cost of installation is unimportant; the real items for consideration are those of operation and maintenance, because in equipping a grade crossing with interlocking there has been established a fixed expense amounting to about $1,500 per annum, or five per cent interest on $30,000 represented capital. In many cases this sum of money is more than sufficient to separate the grade lines and establish an overhead and underneath crossing. The application of this principle can be applied only within certain well-defined limits wherein the true measure of economy has been determined from a thorough consideration of the question, but it is obvious that it becomes the duty of an engineer to weigh carefully every proposition which leads to increasing the fixed charges of a railway.

The President:—I think the remarks of Mr. Morgan are very pertinent to the general object of economy. Are there any further remarks on this subject?

I see very plainly, so far as this Committee is concerned, that the work is so technical, and that there are probably very few members who are familiar enough with the details of interlocking work to discuss it; but the report of this Committee is very exhaustive and complete, and the outline which they suggest in their report is very comprehensive and indicates a line along which they should do very efficient work.

I suppose you have all heard the story about the new Superintendent who went to a road down in Mississippi, I believe it was; he had his car on the rear end of his train, as usual, and he told his roadmaster that he wanted him to get a lot of blocks of wood and paint them red and put them on the rear platform. The roadmaster asked him: "What do you want those blocks for?" and he replied: "I want them to throw off whenever I see a low joint that needs attention." The roadmaster said: "If you will throw them off where we don't need to do any work you will save blocks and time and money."

Now, the application is this: Our time is very limited, and if we move to accept this report and thank the Committee, it will

take time, and I would suggest that we dispense with even that formality and let the committees consider themselves thanked, unless other action is taken. Gentlemen of the Committee, you are excused. The Committee on Ties will please come forward.

The Committee on Ties came forward, headed by their vice-chairman, Mr. G. W. Kittredge, Chief Engineer Cleveland, Cincinnati, Chicago & St. Louis Railway, in the absence of the chairman.

Mr. Kittredge:—Mr. Chairman and gentlemen, I am sorry that this report of your Standing Committee on Ties could not be presented by the chairman in person. In his absence I must present it to you in the best way that I can. It is a matter of regret also that our Committee is represented by such small numbers, but if you will bear in mind the statement about valuable packages not always being in large bundles, I will proceed with the report:

REPORT OF COMMITTEE III.—ON TIES.

To the American Railway Engineering and Maintenance-of-Way Association:

In compliance with a resolution of the Board of Direction, requesting the chairmen of the standing committees to prepare papers treating briefly of the subjects assigned them, I beg, as chairman of Committee III.—On Ties, to submit the following:

I think the subject of ties can be best studied from carefully-kept statistics. In all publications relating to either the preservation or uses of ties, one is struck by the absence of accurate statistical data. From past experiences I should say that, in looking after the interests confided to them, railway engineers and maintenance-of-way officers derive the greatest assistance from constant and close considerations of results attained on the lines of their neighbors and connections, as shown in statistics of operation. I would, therefore, most urgently recommend that blank forms be printed by the Association and sent out to all members, with a request that at least some of the data called for be furnished, if it be found impracticable to furnish all, believing that, after the first few years, the value of this information will be so patent and highly appreciated that little or no difficulty will be met with in procuring everything desired. Objections on the score of expense are perhaps to be expected, but it can be asserted with confidence, based on experience, that the amount of work necessary to fill these blanks from year to year is insignificant, indeed, incredibly so to anyone who has not tried it. As in all undertakings, the beginning will be the most difficult to accomplish, but, once having started, maintenance-of-way officers and engineers will find that the data can be added from year to year with the expenditure of very little time or money.

Statistics of Tie Renewals on ..... Railroad. Year ending .....19.....

Division.	Miles of road operated.			Per mile of road.		Per cent of renewals to number in track.	Total number of ties renewed	Gross tonnage of rolling stock passing over track.		Maximum weight of		Wt. of rail per yard.	Percentage of main line tracks.				Average cost of ties at distributing point.		*Total cost of tie renewals.	
	First main track.	Additional main track.	All tracks including sidings.	Average number ties in track.	Number of ties renewed			Per mile first main track.	Per tie renewed	Locomotive and tender in tons.	Fully loaded freight car in tons.		Curved	Tie plated	Ballasted	Laid with treated ties	Treated.	Untreated.	Per mile first main track.	Per mile of all tracks
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
Total.....																				
Total, previous year....																				

*To include cost of cross and switch ties, tie plates and spike plugs, but not the labor of placing in track.
Use mileage in column 2 for computing averages in columns 9, 20.
Use mileage in column 4 for computing averages in columns 5, 6, 21.

Form No. 1, given above, is proposed. It gives in condensed form all information about ties that an operating officer could reasonably want. Additional information bearing on the life and comparative cost of ties of the various kinds of wood, treated as well as untreated, should be obtained on blank forms, when the work of the Committee is divided up. The footings by railroad systems of the columns of Form No. 1 should be tabulated annually and would furnish a mine of information nowhere else obtainable, constituting in itself the most instructive annual or progress report that the Committee on Ties could possibly present to the Association.

Together with this statistical statement I would suggest the rendition of other annual statements in the nature of progress reports, showing what is being done in the way of preserving ties, what results have already been obtained from the various methods, and what has been determined to be the average life of ties of various kinds of wood.

Some of the subjects to be handled by the Tie Committee can be pretty well exhausted with one thorough investigation, while others are of lasting interest, and, to be properly understood, should be studied over long periods of time, therefore requiring progress reports annually. In the first category we might place inspection, disposition of old ties, methods and general questions, while in the second category we might place the subjects of material, preservation and cost.

I think the chairman should supervise and direct the general work of the Committee and should prepare the annual progress reports. The vice-chairman should send out the blanks calling for general statistics, and should tabulate them for the consideration of the general Committee, forwarding them to the chairman at least sixty days before the annual convention of the Association. To the other members of the Committee should be given the investigation of the separate subjects assigned the Committee, each making a report to the chairman sixty days before the annual convention, the distribution of the subjects, of course, to be made by the chairman.

At least one annual meeting of the Committee should be held, preferably a few days before the annual convention, when the annual report, as prepared by the chairman, can be considered and voted on by the Committee before being submitted to the Association.

Respectfully submitted,

J. KRUTTSCHNITT, Vice-President and General Manager Southern Pacific, San Francisco, Chairman;

G. W. KITTREDGE, Chief Engineer Cleveland, Cincinnati, Chicago & St. Louis Railway, Cincinnati, Vice-Chairman;

J. J. FREY, President Florence & Cripple Creek Railroad, Denver, Colo.:

J. C. NELSON, Division Engineer New York Central & Hudson River Railroad, New York;

W. L. DARLING, Assistant Chief Engineer Northern Pacific, St. Paul, Minn.;

O. CHANUTE, Consulting Engineer, Chicago;

WILLIAM ARCHER, Principal Assistant Engineer Baltimore & Ohio Southwestern Railroad, Cincinnati, Ohio;
W. C. CUSHING, Engineer Maintenance-of-Way Pennsylvania Lines West, Pittsburg;
LEWIS KINGMAN, Chief Engineer Mexican Central Railway, Mexico, Mex.;

Committee.

Mr. Kittredge:—In addition to the report of the chairman, which I have read, I will say that the form submitted is submitted as a suggestion, as it is, in our opinion, much easier to criticise and get at what we want by offering something which can be attacked.

I was at one time in my career Engineer of Maintenance-of-Way of the Muskingum Valley division of the Pennsylvania Lines West of Pittsburg. At that particular time there was very little ballast on a large portion of the road. We had a great deal of old iron there, very few ties, and labor was scarce. I was going over the road one day with the supervisor—by-the-way, one of the best little supervisors I ever knew—John Ward. It was in the spring of the year, the weather was not favorable and the track was pretty rough, and I presume I had been making life a burden to him, until the limit of patience was reached. As we passed a section of track near Washington Courthouse, I said: "Well, John, you must do something about this track; it rides very bad, and I hear a great deal of criticism about it." "Yes," said John, "any d—n fool can criticise," and, bearing that in mind, we offer this as something that can be criticised. (Laughter.) We do not think the thing is in complete form, just as it possibly will be to send out, yet it is in some shape, so that it can be looked over and modified.

The President:—I don't suppose that Mr. Kittredge felt that you were all qualified to criticise. (Laughter.) But the subject is now open for discussion, and we would like to have a full criticism, whether you classify yourselves or not.

Mr. C. E. Lindsay, Roadmaster Southern Railway:—The Committee seem to confine themselves to the consideration of wood ties. Are we not to have any consideration of metal ties?

Mr. Kittredge:—I will say for the benefit of the member that if he will look at the subheads under the question of ties he will find that metal ties are especially mentioned there. That is found in the little pamphlet that has been distributed, and not

in this report. There are seven different subheads suggested in that report, and we did not think at this time it was important or necessary for us to refer to each one of them in detail.

Mr. Hutchinson, Asst. Gen. Agent Pennsylvania Railroad:—I notice that in a footnote, referring to total cost of renewals, it says: "To include cost of cross and switch-ties, tie-plates, and spike plugs, but not the labor of placing in track." I would like to say that on one division that I was on once we kept a very careful account of the actual proportion of track labor involved by the renewal of ties, and we found it had a great deal of bearing on the subject, and we also found that the following year—after we had presented the matter to our officers—we were allowed a little more freedom in renewing ties, because we showed very conclusively that taking out the ties a little sooner saved considerable in track-labor. I do not know whether the Committee considered that or not. I think it is well worth looking into. Do you catch the point, Mr. Kittredge?

Mr. Kittredge:—I do not.

Mr. Hutchinson:—We found our track-labor was running very high and about forty-five per cent of the whole was caused by cross-tie renewals, and we looked into the matter, and we got a little better quality of ties. We renewed a little more extensively the following year, and we found in the third and fourth year, as a consequence, that our track labor was reduced, because we had a better quality of material in the track, and by making renewals a little sooner we found that it reduced track-labor. I do not know if that was what you had in mind.

Mr. Kittredge:—It was expected to get the cost of the various kinds of ties themselves. The cost of putting them in the track would vary in the different localities. I appreciate your remarks about the better qualities of the ties, but I fail to appreciate the force of renewing the ties earlier than you had been doing. I would understand from that that you would not get the full value of the tie in the track. I know some pieces of road where the theory is never to take the tie out unless you take it out with a shovel. I do not think it is wise to go to that extent, but I do believe in getting the full value of the tie before renewing it.

Mr. Hutchinson:—In that batch we included surfacing of our track with old ties, and with them, of course, the track was

bad. It takes more labor to keep the track up. I did not, perhaps, make that clear, but that was included. When we get good ties in, we do not have to spend as much money on maintenance.

Mr. E. E. R. Tratman, Resident Editor "Engineering News":—I only want to make a suggestion. I made a statement similar to this table some time ago in the discussion of preservation of ties before the American Society of Engineers, and I included the tie-plates. That makes a very great difference in the life of your ties, whether the ties, all of them, or only a certain proportion (as at joints or on every other tie), have steel tie-plates. I think that should be included in the tables.

Mr. Kittredge:—The cost of the ties and percentage of ties plated is referred to in column 16, and in the note below the cost of the tie includes the tie itself, tie-plates, and spike plugs.

Mr. Tratman:—There is another point: That is, the difficulty of finding what is the life of the ties after they are once put in. It is hard to know when they are put in. Very few records are kept, unless the ties are of special importance. I think Mr. Kittredge tried marking them with hammers. I do not know whether those marks remained long enough, but it seems to me some system of marking with tacks or tags should be used if you are going to keep any accurate records.

Mr. Kittredge:—In regard to the marking of ties, that was started on one of our divisions in 1892 or 1893. We had a steel hammer made with the letters or figures "92" on it, and that was driven into the end of the tie and into the top of the tie on the line side. We did not find that it worked very well, because at the end of a few years a great many of the marks were effaced and the practice was discontinued, having been kept up only about three years. We found that so large a per cent of the marks had gone—whether we did not mark them sufficiently in the first place, or whether any marks we had put on in that way would have been eroded or not, I cannot say—but the practice was discontinued after a few years on account of its not furnishing us the information that we thought it would give us.

Mr. Samuel Rockwell, Principal Assistant Engineer Lake Shore & Michigan Southern:—On our road we have been marking ties since 1893. I have been using a cast-iron hammer and a very large figure three, four, five or six—of course, you can

guess at the ten—and the "three" marks are still discernible, although they are dim; but we mark all our ties, and think it pays.

Mr. W. G. Curtis, Engineer Maintenance-of-Way Southern Pacific:—I am familiar with the method of keeping account of ties in the form of this blank. It adds only a very little to a blank that we have been using a great many years, and I would like to add a little emphasis to the proposition that it is not much work. When you have once made up the proper form of report that leads up from the section foreman and then to the main office, the amount of work involved is very little. It may look like a big job to start it, but it is not difficult to keep it up.

We have practically all of the statistics of our line that are required by that blank. We have had them for about ten or twelve years. As to marking, our method is the same as indicated by the last speaker. We make a cast-iron hammer—quite a large one; the figures are raised on it about one-eighth inch, perhaps a little more, and we have been using those since 1892 or 1893. There seems to be no very great difficulty in reading them. In some sections, where they are very much exposed, they may sometimes be obliterated, or may be a little dim, but for practical service we find they answer the purpose. We use that for pine ties, redwood ties and cedar ties. That hammer is turned into the scrap pile every year and another one made.

I think it important that the life of ties should be determined in some such way. I think the better way may be to use a galvanized tack, such as our friend here, Mr. Chanute, has devised, with date on the head. The imprint with the hammer looks very feasible, and is not very expensive, but in places where the nature of ties and climatic conditions would make the hammer marks illegible, certainly a numbered nailhead is not very expensive and not very difficult to apply.

Mr. A. Torrey, Chief Engineer Michigan Central:—The marks of 1893 were put on ties on the Michigan Central, and the ties are still in and show those marks.

Mr. Curtis:—We keep no special account of the life of ties, except the treated ties. We have established in our practice to our satisfaction the average life of ties of ordinary timber—the redwood tie, for example. We know about how long it will last, and, of course, we have, through long years of renewal, the

average number we put in in a year. That fixes the broad average of the lifetime for them, but we keep a special account of the life of all the treated ties, and probably shall do so until we establish it. The life of untreated timber, as we all know, varies a great deal, according to the soil, according to roadbed, and the climatic conditions. To illustrate: In Nevada, or in Utah, in the bottoms of the old lake beds, where the soil is pretty well filled with salt and potash, there are ties still in good condition, not a particle decayed; they were laid when the road was built in 1868, but in that same country there are stretches of light, sandy loam roadbeds, where the same kind of tie will go to pieces in three or four years—sometimes, in some places, in less than that; but, as I say, during long years of operation we have made up our minds pretty well about the ordinary, untreated tie and the redwood tie, and we are only concerned now in knowing what will be accomplished by the treatment of ties, which we began about twelve years ago on our Atlantic properties, and about eight years ago on our Pacific properties—the latter aggregating about 5,500 miles.

Mr. Torrey:—I would like to ask whether those ties are marked at the time of inspection or at the time of putting in the track.

Mr. Curtis:—At the time of putting in the track. It is part of the duty of the section foreman—a rule which the roadmaster is required to enforce—that when the new ties have been laid in track, men walk along with a sledge and strike the date of putting in the tie.

We do not consider that a tie deteriorates much meanwhile, and, for that matter, there is only a short interval between treatment and use of the tie. We do not carry them much ahead in stock. I do not know that we carry them quite long enough, but it so happens that we generally want a tie in the track as soon as it is treated and ready to go in. We treat, I might say, all the pine and spruce ties.

We have a large, portable treating plant, which will treat about three thousand ties a day, which we set up at the various places, and the effort always is to interpose it between the place where the ties are delivered and the point of use, so that there will be no extra hauling of the ties on account of the treating process.

I might say that the California tie situation is not just now very satisfactory. We bought about a quarter of a million ties way down in Texas, and this portable plant we shall move from its present location about twelve hundred to fifteen hundred miles, down to a point near El Paso, and treat these ties on their way from the point of delivery to the track. We consider the portable plant one of the most useful plants that we have in connection with the handling and treating of ties.

The President:—I would like to make a few remarks personally on this tie question. There is no one item of railway maintenance that there is as much money involved to the roads as there is in the tie question. On the road I am connected with—the Illinois Central—we use for our maintenance, renewals, and for our new sidetrack construction-work on an average about two million ties a year, costing us between $600,000 and $700,000 for ties alone, delivered alongside the track. The work of this Committee is a very important one, and it seems to me that their first step should be to gather information in the form of blanks, which they can circulate at the expense of this Association under our arrangement for that work, so as to get from all the roads definite information as to what they are doing, in order that we can all make our reports on the same basis.

As it is now, I presume there are no two railroads in the United States who handle that question along the same lines. It has been our custom to make our tie inspection in the autumn, and require our supervisors, who have charge of about one hundred miles, to personally walk the track with their section foremen and take a memorandum of the number of ties for each individual mile that, in their judgment, needs renewal. These reports are made to the Roadmaster, who has charge of from three to four and five hundred miles of track. From the Roadmaster the report goes to the Superintendent, from the Superintendent to the Assistant General Superintendent, and thence to the Chief Engineer. From the Chief Engineer these reports go in to the management in making up the annual budget. The reports go as far as the Chief Engineer, indicating the exact number of ties for each individual mile. For instance, each division reports what it needs as a whole, and each supervisor's section, to the Chief Engineer; any intermediate officer can turn to that report and can see how much is wanted on the

work under his charge. It is our custom to have the Roadmasters and Superintendents go over their division and take this report and pick out individual miles and walk the track themselves in order to gauge the judgment of their respective supervisors.

During the time that I was Chief Engineer—and I presume our present Chief Engineer follows the same course—I used to go over that inspection and those reports and take the Assistant General Superintendent and Division Superintendent, and we would pick out special miles where new ties were recommended. We would walk the track and count those ties ourselves in order to check up the judgment of the division officers and of the supervisors. When the final demand for ties was made, these reports were taken into consideration, and the normal amount of ties needed for the renewals based upon our record of ten years past, the number of ties taken out of the track, and our general judgment as to the necessity for those renewals. After this system had been in use several years we were able to educate our supervisors, our section foremen, and our division officers also to such an extent that for over five years I do not think we varied any in the allotment of ties that came in from the division officers' recommendations.

In the spring, after the ties were allotted, distributed, and put in the track, the bad ties were piled up and those piles were frequently inspected by the officers, in order to see the nature of the ties that had been taken out of the track before they were destroyed or used for other purposes. You cannot surround the tie question and the treatment of ties with too much actual care and supervision. You may, on some divisions, have ties taken out of the track that could last economically one or two years longer, or three years longer, and you may, on other divisions, be too saving, and it is a question that requires the greatest care and consideration to properly and economically handle. It is very important for us to know not only the normal life of different characters of wood and different characters of ballast and in different climates, but to be able to determine about what the normal renewals will be, so that if our division officers on a certain division are recommending each year more ties than the character of the climate, the character of the ballast and character of material would seem to warrant from the records which we

get from the country, those particular men can be looked up and more closely watched, to see whether they are getting things correct or not. It is only by close methods of this kind that we can economically handle the tie question.

Mr. Curtis:—You have stated exactly our general specifications for the care and use of ties. Personally, I regard the looking over of the old tie piles as perhaps the most important point of all. All ties, as they are taken out of the track, should be held until inspected by the proper officer. Sometimes ties will be taken out and properly used in sidetracks. They should be piled in one way. The ties entirely useless, which are to be burned on the ground, should be piled in another way, and the new ties still in another way. You will then have a quick check on the judgment of foremen and division officers. If you can find any serviceable ties piled in the manner specified for useless ties, you have the text for the sermon to be delivered with any emphasis you think necessary; but so long as a responsible officer sees all ties in the useless pile before they are destroyed, we can be pretty certain that no ties will be improperly used.

The President:—I think it will be a great deal of interest for us to hear in a few words from Mr. Chanute the present situation in regard to the treatment of ties.

Mr. O. Chanute, Consulting Engineer, Chicago:—I will say that abroad all ties are treated. This obtains almost through the whole of Europe, and no ties are laid down except after they have been treated. In this country, out of about 100,000,000 of ties which are renewed annually, something like one per cent has hitherto been treated. This year it is probable that about two and one-half or three per cent will be treated with various preservatives, but I entirely agree with what the Chairman has said as to the probability of our soon arriving at a tie famine, and I feel very confident that the best economy will lie for our roads in adopting for themselves various methods of chemical treatment. It was for the purpose of obtaining information as to what had been done abroad for the last sixty years that I went there last fall and gathered a large volume of information which will be very much at the service of the Committee.

The President:—Is there any gentleman present who is at all conversant with the record of metallic ties? Did you look into that, Mr. Chanute, when you were abroad?

Mr. Chanute:—The metallic ties are looked upon with but little favor at present. A great many miles have been laid with metallic ties, but it has been found that mistakes were made—that they were not made heavy enough, that they rusted, and when an accident occurred they were distorted and could not be used again, so that there has been a reaction against the metal tie abroad. All the roads in Germany, in France, and in England are laying down wooden ties creosoted, or treated by other methods, but chiefly creosoted.

The President:—Are their records full enough to give an idea from actual service of the increased length of life through treatment?

Mr. Chanute:—It depends very much on the thoroughness of the treatment. The English creosote their ties at the cost of about twenty-five or thirty cents, and they get fifteen or sixteen years of life.

The President:—That is additional?

Mr. Chanute:—No; life in the track. The French do the best work by injecting sixty pounds of creosote at a cost of sixty-five cents a tie, which is simply prohibitory to us here, but they get a life of from twenty-five to thirty years with the most perishable woods there. Beech ties last an average of twenty-seven years in the track under the heaviest traffic, and then, in the periodical relaying, the best ties are taken up and relaid in the sidetracks, where they last seven or eight years more. In Germany they obtain fifteen to eighteen years' life from ties, which are chiefly of beech and the pine, but the life depends very greatly upon how thoroughly well the work is done, the precautions that are taken, the inspection at the various points, and especially upon the care which is taken as to the drainage of the ballast and the mode of fastening. I would say for the information of members that the spike is practically abandoned abroad. It has been replaced with a lag screw. There are still spikes used in a small way, but they may be said to have disappeared as track fasteners. The advantage of the lag screw is that it holds the rails firmly to the tie, prevents cutting, prevents that flapping which is so injurious, and especially prevents the collection of moisture into the spike holes to begin the process of decay. I hope that the members will experiment with lag screws as a means of fastening. I am thoroughly satisfied that the spike is

a relic of barbarism, and that it will probably disappear in this country within a few years.

Mr. Torrey:—We appreciate very much what Mr. Chanute has said. A good many members, perhaps, of the Western roads especially, and I myself, have been interested in forestry, and would be glad to get some information in regard to this matter as applying to countries where the wood is scattering or where there is no wood at all. I would like especially to hear in regard to the culture of the catalpa tree.

Mr. Chanute:—In regard to forestry, most of the European nations have taken the matter in hand. Many of the forests belong to the State, and they are cared for and regulated by the State, and even the private owners are hampered by regulations, so that they may not cut down the forests unduly. In England, practically all the tie-forests are gone, and England is importing all of its ties; therefore, it is not necessary to apply any regulations there as to the cutting down of the woods. In Germany and France the State owns large bodies—about twenty per cent, perhaps, of the forest area—and regulates this by careful inspection; plants trees and new forests; regulates their cutting down and thins out the woods when they require it, and regulates the cutting of forests belonging to private individuals.

In the specifications for furnishing ties the contractor is required to state from what district—in what district—the ties are to be cut, and the agents of the State supervise the cutting, so as to make sure that the cutting shall be done to the best advantage and with the least possible destruction of the forest growth.

We have had in this country for the past twenty years a forestry department which has been preaching the proximate destruction of the forest. We have paid little or no attention to it, and we have at length arrived at a point where it will be a matter of very great concern to us to adopt some similar measures—less fraternal, probably, than those which are used abroad.

The President:—Are there any others that can give us any light on this question, or have any of the members any further remarks to make on the tie question?

Mr. Tratman:—I was just about to state in regard to metallic ties that I had a communication from Germany a few weeks ago, in which it was stated that about one-third of the ties ordered

for the government railways of Prussia for renewals during the present year were to be of steel. I also had a report from Switzerland, in which they report continued favorable results; they are now using heavier ties, and the Gothard Railway uses steel exclusively, excepting in the tunnels. They are very largely used in India, where they have a hot, dry climate, and in South America and Mexico they are also used extensively—both in the wet and in the dry sections.

The President:—There is one question in regard to metallic ties, and that is their behavior where they are used on railways that have electric circuits or systems, and where the tracks form circuits. I suppose it may be possible to overcome any interference by proper insulation, but it will be a problem in the question of using the metallic ties.

Mr. Kittredge:—On the subject of forestry I want to state the very limited experience which the road with which I am connected—the Big Four—has had in regard to setting out trees. The State of Indiana has recently passed laws in regard to the establishment and maintenance of forests. If a certain number of trees per acre can be maintained over any specified and described portion of land for a period of three years, that land can be entered for purposes of taxation as forest land, and taxes can be paid on a valuation of one dollar per acre.

Our company has, in a number of places, abandoned gravel pits and pieces of outlying property, which are not in daily use in connection with the operation of the road, from which they derive no benefit except the benefit of taxation. Last fall one particular piece of land, containing about thirty acres, was plowed and cleared and set out during the fall with some thirty thousand catalpa trees, and we expect during the present month to set out about twenty thousand additional; the land last year was not in condition for the additional number, on account of growing crops, to be available for that purpose, but we will treat it this summer. These trees were contracted for at the price of one cent per tree—that is, the fifty thousand trees were set out—or they will all be set out this spring—they were to be set out and taken care of for two years for the round sum of five hundred dollars. It seemed to me that that was an offer which our company could not afford to let go by, and I succeeded without any difficulty in getting the appropriation for it.

We are, of course, very much interested in it, but it is entirely too early yet to say with what success we shall meet. A report recently made on the condition of the trees set out last fall indicated that quite a number of them—perhaps one or two per cent—had been thrown out of the ground by the winter's freeze, but apparently were not damaged, and the remainder were not disturbed.

We have one or two other small tracts of land that we have set out with catalpa and other quickly-growing trees for the purpose of seeing how they will develop in the way of furnishing timber partly and partly to reduce our taxation.

Within the city limits of Indianapolis we have an old abandoned gravel bed of some five or six acres, that we set out with trees a year ago—mostly catalpa—and entered that with the State officials as a forest. At the end of three years we will make quite a saving in our taxes on that particular piece of ground. These taxes have been quite heavy and we will make a saving, even if we don't get any results from the timber.

The trees set out on that ground over a year ago average in growth about two feet, I think, during the past year, and I suppose that ninety per cent of those that were set out are still alive and growing. The report is, of course, a very meager one, and is given to show that a beginning has been made.

Mr. D. Bontecou, Chief Engineer Kansas City, Fort Scott & Memphis:—I would like to ask Mr. Kittredge what specially led to the choice of the catalpa tree.

Mr. Kittredge:—The principal consideration was its rapid growth, and its value as a tie-timber and as fence-post timber, and as timber to be used in connection with other railroad work, especially where it comes in contact with the ground. It is one of the most lasting timbers that we have in our immediate vicinity, and it grows very rapidly. It is estimated that within eight years we will have trees large enough to make fence-posts, and that within sixteen years we can begin to cut timber for ties.

Mr. Bontecou:—I am interested in asking that question, because the Fort Scott & Memphis road planted, some years ago, two square miles with catalpa timber, and I think there is hope that some time this year they may cut some fence-posts, but they have never got any ties out of them, and I think that covers an experience of twenty years.

Mr. R. C. Barnard, Engineer Maintenance-of-Way Pennsylvania Lines West:—For Mr. Kittredge's information I would say that about fifteen years ago we set out on our road about twenty-five thousand of these catalpa trees with the idea that they would in a short time make good ties or fence-posts.

To-day I should think that eight inches would be a fair average diameter for these trees. They were unfortunately set on both sides of the track, and it takes a man about three months each year to keep them trimmed so that they will not interfere with the telegraph wires. They are of rapid growth of branch, the young shoots growing from ten to fifteen feet in a season, but the size of the trunk does not increase very rapidly. Our experience with them has been disappointing.

Mr. Curtis:—It occurs to me that it requires some study to hit upon the tree that is best suited to the different climates. We in California planted catalpa trees some twenty years ago; at the time there was much said about them in the press—about the time there was the first agitation about it. We scattered these trees broadly over the State, and now they are twenty years old and they don't average over four inches in diameter in the best places, and in other places they have not grown at all, except in the shape of a shrub. They have not actually grown into a tree. The places where they have grown best is in the moister parts of the State, and the places where they are not thriving is in the drier parts, and my impression is that there is no general rule that can be applied. In California it is our experience that they require the moist soil, and certainly they will not grow in the dry places and through the dry, hot summers.

The President:—Our time is so short we will have to close this discussion at this time, although it is a very interesting one, and the Committee have treated the matter very thoroughly and the discussion has brought out some very important points.

I will next call on the Committee on Ballast. I now have the pleasure of introducing Mr. Peddle, the vice-chairman of the Committee.

Mr. W. H. Peddle, General Superintendent of Maintenance Southern Railway, here read the report of the Committee, as follows:

REPORT OF COMMITTEE II.—ON BALLASTING.

To the American Railway Engineering and Maintenance-of-Way Association:

Pursuant to the circular issued by our President and Secretary, under date of February 12, this short paper has been prepared in the endeavor to outline the scope of this Committee's work, and suggest the manner in which it may be carried on. The intention of the speaker is simply to bring the subject-matter before the convention in the hope of provoking general discussion by the members at large now assembled here, so that your Committee may have the benefit of this discussion when it meets to take up its work.

Ballast may be defined as the material above the roadbed in which the cross-ties are imbedded, and its object is to get a solid and uniform bearing for the cross-ties, to distribute the applied load over a large surface of the roadbed, to hold the cross-ties firmly in position, to give elasticity to the track and to allow water to pass off freely, thus avoiding churning in wet weather and heaving by frost. The importance of ballast for the proper maintenance of track is pretty generally conceded and understood.

The five subdivisions of ballasting, as outlined by your Board of Direction in the programme are as follows:

1. Material:
   - (*a*) Stone—size, quality;
   - (*b*) Gravel—cementing, loose, sandy;
   - (*c*) Burnt clay—quality, method of burning;
   - (*d*) Slag, cinder, and burnt shale;
   - (*e*) Chatts—character;
   - (*f*) Earth;
   - (*g*) Dust prevention.
2. Standard cross-sections (variations, modified by material and other conditions).
3. Cost:
   - (*a*) Material alone;
   - (*b*) Loading;
   - (*c*) Transportation;
   - (*d*) Unloading;
   - (*e*) Placing under track;
   - (*f*) Surfacing and dressing.
4. Methods:
   - (*a*) Handling material;
   - (*b*) Keeping trace of cost and accounts.
5. What constitutes ballasted track?

The arrangement of these subdivisions is admirable, and the scope covered by them well-nigh complete. It is desirable, in discussing the subjects covered, that they be taken up in their regular order, and that

members call attention to any subjects pertaining to ballast that do not appear to them to be contained in the list.

If no better method is suggested, it is the intention of the chairman of this Committee to assign a particular subdivision of the committee-work, as outlined in the programme, to each of the five committeemen, who, with the chairman and vice-chairman, compose the Committee. Each of these committeemen, with the assistance of our Secretary, will collect statistics and tabulate them to accompany their reports to the chairman, who will submit these reports to the other members of the Committee for their suggestions and criticisms, after which the Committee, from time to time, will meet for discussion and to prepare its reports.

In an effort to slightly elaborate the list of subdivisions, as contained in the programme, the object will be more to acquire knowledge than to impart it.

Subdivision 1: Material.—(*a*) Stone—size, quality. There exists a wide diversity in practice with regard to the size of broken rock ballast, although the tendency appears to be now in the direction of the smaller sizes.

The question to be decided is, What sizes are the best, taking into consideration the various locations and conditions under which the ballast may be used?

The quality of stone should be such as to resist disintegration under tamping or from the effects of the weather. What are the other requirements as to quality?

(*b*) Gravel—cementing, loose, sandy. Gravel is, perhaps, the material more largely used for ballast than any other, occurring, as it does, in large deposits, widely distributed, as gravel pits deposited by water in the past, as well as in river and creek bottoms of the present. It is usually readily accessible, cheaply loaded, and with it track can be economically maintained. In considering the economic maintenance of track, the character of the gravel will have to be taken into account—whether it is cheaper to maintain track on cementing gravel, or on loose, or on sandy gravel. Here, as in many other cases, it will be necessary to encroach upon the subjects allotted to other committees: What is the cost of renewing ties in the different kinds of gravel, as also in the other materials used for ballast? What is the life of ties in the different kinds of ballast? What is the effect of the sand on wear of rails? We might even carry the inquiry outside of the department interested in the maintenance-of-way, and ask what effect has the sand on the tires of rolling-stock? This may seem, at first sight, a little far-fetched, yet the records of the Louisville & Nashville Railroad for the Mobile and Montgomery division now show an average of 16,000 miles run to 1-16-inch wear of engine tires, whereas formerly 9,000 miles was the average, and the superintendent of machinery attributes the difference to be due to slag ballast having been substituted for sandy gravel ballast. If the tires of an engine are so greatly affected by the use of sandy ballast, what is the effect on other parts of the rolling stock?

(*c*) Burnt Clay—quality, method of burning, etc. Having had no personal experience with this material, it will be passed, with the hope that members who have had such experience will enlighten us. It would seem that where a good natural ballast is readily accessible, an artificial article would not be advisable, and that the distance from nearest coal-field would enter largely into its cost.

(*d*) Slag, cinder, and burnt shale. The use of slag as ballast is growing in favor. In the South, the "hot-pot" slag from the iron furnaces is of particularly good quality for this purpose. The slag is poured from hot pots, run on trucks to the dumping point. It spreads itself in thin layers, which renders it hard and brittle, easily broken to suitable size for ballast. The slag formerly made at these furnaces was of a porous character, hard to break to the proper size, and with a tendency to cement together again, hence it made poor ballast.

Cinder—Cinder is a waste product on all railroads that run coal-burning engines. It is used by most of them as ballast; if not on their main lines, then in yards and for sidetracks. Where the roadbed is soft, excellent results have been obtained from its use.

It is claimed by some that cinder ballast is destructive to both the ties and rail. The experience of the members present in this particular, as well as all others, would be instructive.

Burnt Shale—The speaker has no personal knowledge of this material, so that any remarks with regard to it will be information to him.

(*e*) Chatts—character. Chatts are the tailings from lead mills, and are about the size of very coarse sand. The lead ore is separated from the quartz rock after being crushed.

Chatts are regarded by some of those who have used them as the ideal ballast, easy to tamp, making the renewal of ties cheap; heavy in weight, hence holding the tie in place, and comparatively free from dust. Those who have had larger experience with this material can doubtless tell us a great deal more about it. I have here a sample of chatts which may be of interest to members who are not acquainted with it.

(*f*) Earth—Earth as ballast has been largely used in this country in the past, and few large railroads can be found at the present time that have not some part of their lines ballasted with earth or "dirt," as it is often called, when it is not designated as "no ballast." If it has happily disappeared from the main lines, it is yet to be found on the branches, where light business will not justify more expensive ballast. An interesting question is, How should track ballasted with earth be maintained? In some parts of this country it is customary to crown the earth above the tie in center of track; in other parts of the country it is customary to make the top of the clay ballast level with the top of the tie.

Other materials that have been used for ballast might be mentioned, such as rock screenings, for top surface of yards between the tracks, where they present a clean and neat appearance and render the movements of trainmen easy and safe.

Chert—Chert is also used to ballast branch lines in the South, and is

infinitely better than ordinary dirt, though not the equal of rock, slag or the best character of gravel. It is excellent at road crossings. A sample of chert is also here for the benefit of those unfamiliar with it.

Doubtless some of the members present can add to the list of materials suitable for ballast.

(*g*) Dust Prevention—Until recently, no serious attempt was made to prevent dust rising from the ballast of track, except by permitting grass to grow over the track; for example, Bermuda grass in the South. Within the past few years oil has been used for this purpose, apparently with success. It is claimed to not only lay the dust, but also to prevent growth of weeds. The Eastern roads were the first to adopt it, and it is to be hoped that some representative of that section of the country can enlighten us as to its merits.

Subdivision 2—Standard Cross-Sections (Variations modified by material and other conditions).

To present this subdivision properly it will be necessary to obtain diagrams of the standard cross-sections for ballast of the principal railroads for comparison. Nearly all railroads have adopted such standards, yet they are not, and cannot, be strictly adhered to in all cases. The character of the material of which the subgrade is composed, as well as other conditions, necessitate modifications. The section on curves is, of course, different from the sections on tangents.

Subdivision 3—Cost.—To discuss this intelligently necessitates statistics, which are not now at hand, but which it is hoped to secure later.

Subdivision 4—Methods.—(*a*) Handling Material.—This should include a description of the methods adopted in expending the money covered by the loading, transporting, unloading, placing under track, surfacing and dressing. To attempt to describe the various modes of conducting these operations is not within the scope of this short paper, further than to say that gravity is used as far as practicable, supplemented by steam power, as at the crusher with its screens, at the steam shovel in loading, in transporting, in unloading from dump cars, or by means of plow, and in spreading the ballast. Due care should be exercised to avoid the loss of material in conducting these operations, particularly the last two, else much of the ballast is liable to go down the bank. The placing under the track is accomplished by means of jacks, shovels or ballast forks, and tamping-bars or picks, in addition to which levels and lining bars are needed in surfacing and lining. It is desirable to learn the proportionate force usually employed at these different classes of work, which are all conducted at the same time.

(*b*) Keeping trace of cost and accounts. This is by no means the easiest thing in connection with ballast; that is, if the accounts are to be accurate. In ballasting an unballasted railroad it can be done, but in reballasting a railroad which has already been ballasted, or partially ballasted, where the work of overhauling, re-tieing and possibly re-spacing of ties is being conducted at the same time, it is not so simple. The section foreman who distributes the expense of labor is seldom an expert accountant.

SUBDIVISION 5—WHAT CONSTITUTES BALLASTED TRACK?—No attempt will be made by the speaker to elaborate this subdivision, which will be left for the Committee in its future reports.

Full ballasted track does not mean the same on all lines. It is largely dependent upon climatic conditions, character of material composing the roadbed, weight of rolling-stock, the daily number of trains and their character—whether passenger or freight; nor is it permanent, for it requires repeated renewals from time to time.

R. MONTFORT, Chief Engineer Louisville & Nashville, Louisville, Ky., Chairman;
W. H. PEDDLE, General Superintendent Maintenance Southern Railway, Washington, D. C., Vice-Chairman;
A. MORDECAI, Assistant Chief Engineer Erie Railroad, Cleveland, Ohio;
J. R. LEIGHTY, Roadmaster Chicago & North-Western, Carroll, Iowa;
EDWARD SHELAH, General Roadmaster Wabash Railroad, Decatur, Ill.;
J. T. RICHARDS, Engineer Maintenance-of-Way Pennsylvania Railroad, Philadelphia, Pa.;
H. U. WALLACE, Division Superintendent Illinois Central Railroad, Freeport, Ill.;

Committee.

The President:—Gentlemen, this subject is now open to you.

Mr. W. McNab, Assistant Engineer Grand Trunk Railway:—In regard to dust prevention, mentioned in the report, of course there are certain qualities of ballast where grass, or even weeds, will not grow. And even in those qualities where, with a mixture of earth, it will grow, it is always unsightly, and on a first-class road—and, as far as that is concerned, on any road—it is not allowed, and therefore I think the suggestion thrown out in the report, that we should obtain the experience of those who have used oil, is a good one. We should know the description and quality of the oil, and the methods by which it is used—whether by a tank sprinkler attached to a train, or by an ordinary nozzle, used by the section men, as well as its cost; and, in speaking of cost, and the cost of ballasting, I know that there are so many conditions on which this depends and the difficulties in arriving at subdivided details are so great, that it has been no easy matter in the past to formulate figures for comparison. I think, however, that if every member of this Association and every engineer who has any work under him, whether in ballasting or in any other work that refers to the scope of this Association, would make a special experiment this year to determine the precise subdivided cost of the work upon which he is

engaged, with a view of giving the same to the Association, some understandable basis could be arrived at.

In the cost of ballasting, if the foreman of the pit, the train foreman, the foreman of the track and others interested would all understand what we are striving to ascertain, I think it would assist us, and I am sure we would be able to get some basis which we could use for the purposes of comparison. This suggestion that is thrown out with regard to cost of ballasting, I mean also to cover all classes of works which it may be necessary to refer to in future papers.

The President:—Mr. Hutchinson, can you give us some data in regard to the use of oil? I believe they used it on your line.

A Member:—Mr. Hutchinson is not present—he stepped out a moment ago.

The President:—I think the Pennsylvania used it on some of their lines—that is, some of their branch lines, where they have sandy ballast and the travel is heavy. I was over their branch line to Cape May last July, and they applied oil to that, and while there was no dust flying in the atmosphere, after I had made my trip I ran my hand over my face and found that there was sand and oil there together, so that the dust was not eliminated entirely, but the use of oil kept down the dust so as to allow you to see the track all right.

You can barely distinguish the odor, but it was not disagreeable. The process, I understand, was very expensive, not so much in regard to its practical application, on account of the cost of the material used, but on account of the royalties, and that is so high that it would be prohibitory on large roads—that is, roads that have a large mileage.

Mr. Hutchinson, we inquired of you while you were out. Can you give us some idea of the cost of the use of oil on the Pennsylvania?

Mr. S. P. Hutchinson, Assistant General Agent Pennsylvania Railroad:—I understood it was estimated to be about $50 per mile, but I don't want those figures to be taken as gospel, because personally I have never used any, and I cannot speak positively, therefore, but I think $50 a mile is about right. Mr. Shober here says he thinks it is $60 a mile.

The President:—Is that the material, the application, and the royalty?

Mr. Hutchinson:—I think all three.

Mr. S. L. Shober, Jr., Assistant Engineer Pennsylvania Railroad:—It was crude petroleum oil that was used, and it was applied from an ordinary oil-tank car with a swivel arm. Steam was introduced from the engine to make the oil move freely, and the arm was swung out over the adjoining track. I think it cost $60 a mile for single track, $120 for two tracks, for each application, and they made two applications a year and thought it satisfactory. They spent about $240 per mile per year on it. There were reports of the trouble you mentioned in reference to the accumulation of dust on clothes. I heard there were a few complaints from the passengers—that is, women—in reference to their clothes being spotted by these accumulations. It is being discontinued at the present time between Philadelphia and Atlantic City, however only on account of the desirability of putting that portion of the road in stone ballast.

The President:—It did not strike me as satisfactory. It struck me very forcibly that the cost of oil application, if it had to be kept up every year, would amount to more than what would take care of rock ballast, and cost much more than the interest thereon, and that, therefore, it would not be economy in the true sense of the word.*

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*Mr. J. H. Nichol, Assistant Engineer West Jersey and Seashore Railroad, under date of March 31st, addressed the following interesting letter to President Wallace, with reference to the application of oil to road-bed:

"I read with considerable interest the discussion on page 236, Railway Age, March 16, 1900. Noting your finding sand and oil on your face after a ride over our Cape May division in July, 1899, I would say that only small portions of that division have been oiled, the dustiest locations being selected; the sand came from the unoiled parts, and the oil on face can very fairly be attributed to the natural secretions in as warm a month as July.

"The cost of oil was, in 1898, two cents per gallon, or $40 per mile of single track; the average cost of freight and labor of applying, all charges, including engine service, $5 per mile; total, $45. There is a single payment of $20 per mile royalty which covers the whole life of the patents, so that subsequent oilings would cost about $45 per mile. At present, owing to trade conditions, oil is three and, in some localities, four cents per gallon; the freight and labor charge remains the same.

"The oil is a residuum of petroleum of 24° to 28° Beaumé, practically

In reference to the cost of the ballast work, that is a matter, it seems to me, that the Committee should very carefully analyze, so that when they are asked for information they could give data from all the roads, and give it on a uniform basis. Every person that I know of within my experience, in giving the cost, or in getting the cost of an element, gets it from different divisions of the road, and there is great inequality because

non-evaporative. At any temperature over 50° Fahrenheit it is not necessary to use steam to expel oil from pipes; cost is given above. Any new device will, of course, meet with criticism, and I have heard expressions of opinion that if the dust raised contained oil it would soil clothes, etc. Although connected with the division of the Pennsylvania Railroad where most oiling has been done, and having watched the work closely from the start, I have not found one instance of damage to clothing caused by oil; the fact is, that dust light enough to be lifted by trains contains no oil, or so little that it will not give it off. The dust lifted on our lines is from unoiled portions, or in the oil from extensive disturbances by renewal of cross-ties, and not yet re-oiled. At the latter places, a rain following disturbance floats the oil to surface and practically renews it. We are not discontinuing its use; in fact, have spent an increasing amount of money for this purpose each year since 1897. The year 1899 was such a successful one as regards net receipts (attributable to the use of oil, and in fact dependent upon it, partly at least, as without oil our Atlantic City division would have been unbearably dusty), that we are now stone-ballasting the Atlantic City division, 58 miles of double track, 100-pound steel in 60-foot lengths, only needing stone ballast and automatic signals to make it standard, both of which are now being done. We shall continue to use oil on the Cape May and other branches, and on road crossings on the Atlantic City division.

" . . . We do not expect to continue its use indefinitely; in porous material, with disturbances incident to surfacing or renewal of cross-ties, three applications have penetrated to a depth of seven to eight inches, so that a rain following disturbance restores the oiled surface, as before stated.

"One of the most important results of the use of oil is not cited in the discussion, viz., *the waterproofing of the surface*; track labor is thereby saved; there is no freezing, and, consequently, no heaving by frost in the spring, and no loss of ballast by heavy rains. We have escaped washouts of gravel-ballasted tracks across salt marshes on the coast, submerged in Northeastern storm tides, since oil has been used on them.

"I refrain from adding to this already long letter a list of the secondary benefits, such as prevention of weeds, preservation of cross-ties, prevention of fires from hot coals dropped from engines, etc. I shall be glad to give any information you may desire, and shall be indebted if you will kindly refer this letter, or a copy of same, to the chairman of the committee, Mr. Montfort."

all of the elements are not taken into consideration, or the different people work it out in a different way. For instance, there should be taken into account the cost of the land on which the quarries, or the beds, may be situated, and the royalties you have to pay and the stripping of the beds or quarries, to get at the cost, and in rock ballast, the excavation of that rock, the crushing and the unloading and the loading of it on the cars—all of these should be considered; in the gravel ballast, the excavation of the ballast and the loading of it on the cars and the transportation of it, should be taken into consideration. In considering the ballast work, the special trains that are generally provided for that purpose should be considered, switch engines may be necessary at the ballast pits or at the quarries, and then there is the matter of repair ballast—a great deal of repair ballast may be done, particularly on second-class or intermediate lines, through the handling of the ballast on local freight trains, dropping off a few cars in a place, or dropping the ballast out of the Rodger ballast car and letting the section force work it in.

The next item would be the preparation of the tracks for the ballast—that is, how much work your ballast gangs do in dressing the slopes, cutting the grass out of it, or evening up the bank. The next item is putting the gravel actually in the track, and a careful separation should be made of the tie renewals, which may be made at the same time, and your surfacing or other work—that is, replacing the ties—that is done at the same time.

Now, if an outline of the different elements of cost are carefully thought out by your Committee, and they get the information on the same basis from the different roads, the result of their work will be very valuable to us.

Mr. Hunter McDonald, Chief Engineer Nashville, Chattanooga & St. Louis:—The Committee has stated that ballast is not permanent, and that we know—it requires repeated renewals from time to time.

I think it would be in order for the Committee to report on the life of ballast under various conditions, and I would also think it would be in order for them to report on the method of treating ballast after it has worn out—I mean by that, when it becomes foul. It is the practice on some lines to take the ballast out and sift it and put it back, and on other lines they simply put other ballast on top of it.

Mr. W. C. Cushing, Engineer Maintenance-of-Way Pennsylvania Lines West:—Complete as is the list of ballast materials given by the Committee, there is one material that has been omitted, and that is screened gravel.

We have been cursed with sandy gravel; that is not only dirty, but it is difficult to keep up the track with it, under the present heavy power in use on the different lines.

We have, therefore, started experimentally to use screened gravel. It has not been in use sufficiently long to enable us to determine whether it will be a good ballast material or not. It is just about intermediate in cost between stone ballast and good gravel, so that if it is successful as a track ballast it certainly deserves considerable consideration.

Most of us have to use sand in one way or another, and a good many lines in the West have sandpits on their lines, both for commercial purposes and for their own use. The screening of the gravel can be handled on that account quite economically by using the sand for commercial business and using the gravel on the line.

I think, therefore, it is worthy of further investigation. We have given it a little for ourselves. We hope to continue the use of it in order to determine its value. We were a little apprehensive that possibly the large kernels of gravel might be too smooth to bind well, but so far it does not show that result.

Mr. Curtis:—What is the method of screening adopted by you?

Mr. Cushing:—There is a special screening plant for that purpose, which consists of an elevator and a revolving screen, which reaches over two cars. The men simply shovel the gravel into the elevator, which is in continuous operation, and it is discharged into the screen, which is also revolving continuously, and the gravel drops into one car, and the sand in the other car. The cost will not be over twenty or twenty-five cents a yard. You can use any suitable appliance for that purpose.

Mr. Samuel Rockwell, Principal Assistant Engineer Lake Shore & Michigan Southern:—I would like to ask Mr. Cushing what proportion of sand he gets from the bank; that is, what proportion of the gravel is sand and what proportion is gravel.

Mr. Cushing:—That depends entirely on the location of the bank. The one that we are working in has about thirty per

cent gravel and about seventy per cent sand. If you could get a richer gravel deposit, you could get a larger percentage of gravel, but it depends entirely on the place where the gravel is obtained. We are unfortunate in having a very large percentage of sand on the division with which I am connected, and the screened gravel is intended to be intermediate between the poor sandy gravel that we have at present, and broken stone ballast, with which we expect our lines to be equipped in the future.

The President:—You all know that the Lake Shore has a very smooth track, and I think we would be interested to hear from Mr. Rockwell as to what effect the quality and kind of ballast they use has on that road—that is, what is the percentage of the total effect?

Mr. Rockwell:—Of course, ballast is absolutely necessary for good track; but smooth track is all a matter of standard. It depends upon the work you put on it and the way you do it. The reason why I asked Mr. Cushing as to the percentage of sand is that I have devoted considerable time to determining how much sand there is in our gravel—we have perhaps a dozen different pits scattered over the line—and we have determined that the sand in the gravel from them is just about one-half on an average—about half is sand and half is gravel, varying from the size of a grain of wheat up to an egg. I have been trying to interest our people in the screening of gravel and I am very much interested in what Mr. Cushing has said on the subject. In fact, I have already gotten up a sketch of a machine very similar to what he describes, but the question has been what to do with the sand.

Mr. C. A. Wilson, Chief Engineer Cincinnati, Hamilton & Dayton:—I would like to ask Mr. Rockwell whether the quality of gravel is not the first consideration with them rather than the cost. It has been my experience that sometimes the most expensive gravel is the cheapest, even if it has to be hauled a long distance. I would like to ask whether some of the reasons why the Lake Shore track is so good is not because their first attention is given to getting the very best quality of gravel obtainable irrespective of the location.

Mr. Rockwell:—We have several beds scattered over the line that have cementing gravel, which we have carefully avoided. We use altogether, wherever we can, gravel which does not ce-

ment. Our best beds are those from which the gravel is always loose.

Mr. Cushing:—I would like to say further that I have had some unfortunate experience with cementing gravel also, and I would avoid cementing gravel just as I would the plague, as Mr. Rockwell has done. We know that thirty per cent gravel and seventy per cent sand is bad, because we are troubled after every heavy rainstorm with the going down of the surface of our track, and that is what drove us to the consideration of screened gravel. At the present time some of our divisions are blessed with very excellent gravel in that respect, but the division with which I personally have to deal has no such deposits and I have to find something better.

We are pushing the renewal of the ballast on our road with broken stone, and that will be the ultimate ballast, but it takes a long time to ballast a road fully with broken stone, as a very large quantity is required.

So far as the handling of gravel ballast is concerned, it makes very little difference on a division where the bed is located. So far as the cost is concerned, it is the quality of the gravel that one is after and not the cost, but we can handle gravel from any part of our division for about four or five cents, or maybe, five and one-half cents per yard, with modern appliances, because when we take out gravel ballast we make a regular business of it just as we would with any other business, and the best equipment on the road and the best attention and the best of everything is given to that particular work, and we can handle it in the very quickest possible time, and in the past several years we have never exceeded in such cases six or six and one-half cents a yard, and we have handled it as low as five cents.

Mr. Peddle:—That includes the cost of distributing it?

Mr. Cushing:—That includes the cost of distributing it from flat cars—that is, the ballast unloaded. The reason probably that it has been so cheap is because we had a pit in an excellent situation in regard to the height of face of the bank, so that we were enabled to handle the gravel very quickly, and by having ample equipment of cars for that purpose we were not delayed in that respect. We were not hampered with a fewness of cars. If one is so hampered, of course the cost runs up. It takes about 250 flat cars to run a business of that kind, and haul it 75 miles.

Mr. Curtis:—What is the cost of that as compared with broken stone?

Mr. Cushing:—We are using about two-inch broken stone ballast at the present time, but if I had it at my disposal, I would use trap rock ballast, or something that is materially harder than limestone ballast, and would take it in size from an inch to an inch and a half. I don't think the coarse ballast is good. It makes it harder to adjust the surface of the track, and I would prefer the smaller size.

Mr. Hutchinson:—I would like to say that we are making tests of ballast on the Pennsylvania Railroad that is three-quarters of an inch in size. The dust has been carefully screened out of it, which, of course, increases the cost some. It is a little early yet to say whether it is a success or not. It has been tried on double track. I know of one point where it has been tried on a four-track section of the road on the outside track. I think the longest point at which it has been in use was a double track, where it has been in use five years under rather light traffic. We find that it takes a little less labor to surface the track, and the track is not near so noisy as when coarser ballast has been used. The tamping of the ties with three-quarter-inch stone takes less labor and it does not wear out the tie as fast.

There is the question of price to consider, and, as I say, it has not been in use long enough to allow us to determine it.

Another point—it has not been used at any place long enough to allow a very general renewal of the cross-ties to take place. The question of loss on renewal of the cross-ties will have to be considered, and, by-the-way, it is, what we call bastard limestone, which is harder than limestone for burning.

Mr. Peddle:—What does that cost on the cars?

Mr. Hutchinson:—It costs on an average of about fifty cents—the three-quarter-inch size costs sixty cents per cubic yard on the cars.

Mr. G. B. Woodworth, Rail Inspector Chicago, Milwaukee & St. Paul:—The Committee reports that they have no information about burnt ballast and burnt shale. I would say that our road burned some four or five hundred thousand yards of gumbo, as it is called—burned clay—and they also used burned shale or mine cinders, and both of them have given excellent satisfaction. The quality of the clay depends largely upon the char-

acter of the clay to be treated, the method of burning and the state of the weather. The cost of it, of course, largely depends on the cost of the slack and proximity to the mines.

The President:—What is the cost?

Mr. Woodworth:—The cost will vary. Some of it we get on our own lines and some we have to get from connecting lines, so that the price varies greatly. This is on a line that has no gravel pit, which puts the question of use of gravel out of consideration. The cost of the mine cinders was very low. It was simply the loading of them at the mine.

The President:—Do you not have a great deal of trouble with the dust in the use of clay ballast?

Mr. Woodworth:—It is very dusty when it is first put on the track. There is an ash that forms in the burning, and when first put on the track it is very dusty, but the first or second rain seems to soak it into the gravel, so that afterward it is very clean. It is clean as soon as a few rains have washed off this ash. It is then as clean as stone ballast, and we don't notice any dust arising from the tamping or the renewing of ties, unless it is when there are a great many to be renewed in one spot, which disturbs the ballast to a certain extent. But this is soon remedied by moisture or a rainfall.

Mr. Bontecou:—How long an experience has the Milwaukee road had with that ballast?

Mr. Woodworth:—The first clay ballast was put on the track about 1887 or 1888, and there is some of that that has had to be renewed where it was not put on to a sufficient depth, but where it was put on to a sufficient depth it seems to do very well.

Of course, it has gradually mixed with the soil, as eventually all ballast will, but it was very free from imperfections for a number of years, until it gradually gets a little foul.

Mr. Bontecou:—I am a little interested in that question of burnt clay, because it has always seemed to me that in speaking of burnt clay ballast there ought to be a clear discrimination made as to the hardness and thoroughness of burning. The Memphis road, about seven years ago, indulged in about twenty miles of burnt-clay ballast. It cost, as I recollect, about seventy-five cents a yard for the material placed on the track, and the work was done by a well-established contracting concern, who

made a specialty of doing that sort of thing, and we supposed we had something, but we found within three or four years that the ballast was practically of no use, and the reason may have been that the material was not proper or it may have been that it was not properly burned. I know that certainly was one of the conditions; at any rate, it had to be taken out and replaced by something else.

The President:—In reference to the cost of that work on a mile basis, I will state that our average figures on the Illinois Central, that we use in our estimates—of course, it differs on every division and for every year—but our rock ballast costs us from twenty-five hundred to three thousand dollars a mile on the basis of using approximately three thousand cubic yards to the mile, and a haul of from one hundred to two hundred miles for a completely ballasted track. Of course, that means where the track is put up with regular ballast and includes the surfacing and everything complete. With gravel ballast put up the same way it has cost as low as one thousand dollars, and as high as fifteen hundred dollars, a mile. The gravel ballast, however, includes the shaping up of the banks and the cleaning out of the excavations, in order to prepare the roadbed and crowning it properly for the ballast, so as to give it the proper drainage. The cost of the rock ballast, from an inch to an inch and three-quarters in diameter, is from as low as forty-seven cents to as high as fifty-five cents a cubic yard, loaded on board the cars, and twenty-five cents a cubic yard for the screenings, which are used to ballast city tracks and in the yards and for station platforms.

Mr. Sullivan:—I have noticed in the report on this subject that everything is considered with reference to it from a comparative or relative point of view, which, it seems to me, is only a partial view, and that there is necessity for going further. The order in which the subdivisions on ballasting are arranged places last on the list the one, "What constitutes ballasted track?"

It seems to me that that one should come first. In the subdivisions given in the report the materials come first and the Committee's treatment of them is altogether from a relative point of view.

During the last year I have been forcibly brought up against the limitations of the track, in connection with locomotive de-

signing and in connection with the use of the track in the operation of the road, and I don't feel any hesitancy in saying that from an operative point of view the officials of all roads having heavy fast traffic are directly against the limit, and it would be of great value if we could have some formula defining the limits of the track. We have nothing of that kind at present, and anyone who has to consider services approximating the limit of the track is left entirely in the dark as to what those limits are, so far as any definite statement of those limitations is concerned.

Now, my observation is that limiting conditions are not to be found in bridge designing or construction—the designing and construction of bridges can be carried so far beyond what is at this time needed or required that it does not enter into this question. The rail itself does not appear to be a limiting condition, because we are getting from the rail at present in use about all the service that is required, except, perhaps, as to the matter of economy, but as to the question of strain it seems to be ample. Ties are not a limiting condition, because there is nothing to indicate that the track cannot be made as substantial as the necessities may require, by increasing the size and number of ties, so that we are brought to the consideration of the ballast as a limiting condition.

It is generally held that stone ballast is the strongest. It is better than gravel, but how much better or what its limit is, I have never seen anything to indicate.

I have within the last six months had to assume the limit in the designing of passenger locomotives. The services of the road have called for a locomotive beyond anything that we have at present in use, and in fixing the limit of the design for the locomotive, the condition which appears to be the limiting one, after testing all the elements of the proposition, seemed to be the ballast of the track. To give an idea of what that limit has been assumed to be, I would state that instructions have been given to the mechanical engineers to get up a locomotive based upon the weights of 22,000 pounds per wheel, that is, the driving wheels of the engine, and speeds of from sixty to eighty miles per hour.

The result of the computation on those weights and the speed requirements is an engine weighing between eighty and ninety tons. An engine of that weight running at the speed will

naturally test something—but the traffic conditions are such that the operation must be conducted in that manner.

The importance of having a formula, if such a thing is obtainable, giving the absolute strength of the track, would be of great value.

Assuming, for instance, that the weight is underestimated and that instead of 22,000 pounds per wheel the track would stand weights of 24,000 pounds, the locomotive could be designed of greater efficiency, and when we consider that locomotives purchased to-day will render service for the next twenty-five to thirty years, if you underestimate the limiting conditions of to-day you are losing, for that entire period, just so much in the efficiency of your power.

The point I wish to call to the attention of the Committee is, if it is practical—there is a necessity and immediate use for a formula that will express the ultimate strength of the track or its limiting element, and if, as I assume, that limitation lies in the ballast, that is the point where we should commence by clearly establishing the limitation, and when that limit is ascertained or determined, the limits of the other parts will naturally follow.

I make mention of this fact because of the absence apparently in any one of these reports of the determining element, and would suggest that in consideration of the questions that the committees have to report upon that they will give the information establishing the absolute limit of track service.

The President:—Mr. Sullivan, as far as the ballast is concerned, there may be limitations in respect to the quantity of ballast that is now used, but I don't think there is any limitation in the efficiency of the ballast itself. It is simply a question of a proper quantity, and when you use the proper quantity to make your track strong enough for the weights and speeds which you have, you will find limitations in some other element of the track and not in the ballast. I think your point is very well taken, however, and that we should go into these things in a way to determine the limitations, but it would strike me that we ought to turn it around and that we men of the maintenance-of-way department should not place any restrictions or limitations upon the service of the road. If there are any ultimate limita-

tions, we should not acknowledge it until we have made an effort and a trial to overcome them.

Mr. F. S. Stevens, Division Engineer Philadelphia & Reading:—As to Mr. Sullivan's remarks—we have two passenger engines running with driving-wheel weights of 26,500 pounds.

The President:—We ought to hear a little more about the clay ballast. It is interesting to the South and the Southwest, and places where they have no other kind of ballast.

Mr. W. K. McFarlin, Chief Engineer Delaware, Lackawanna & Western:—As to burnt ballast, I would say, after having had considerable experience with it on our own lines, and watching it on other roads, it was first burned in 1884 or 1885. It was claimed that there was a patent on the process, which developed to be simply on the machinery for burning it.

As to the material from which burnt ballast can be made, gumbo is the best material, but clays can also be used. With whatever material it is burned, especially with gumbo, it swells to probably twice the size of the dirt used; that is, one yard of dirt makes two yards of burnt ballast. The average cost for burning is now about twenty cents per yard. It is light, and a car can scarcely be overloaded with it. If properly burned, you can take a piece of it and scratch glass, as you would with a diamond. It is very sharp, but still very light.

I consider it the best ballast made, if you have the proper material to burn it from, but on account of its lightness, it is not good for new track. It is so light that it will tend to crowd up between the ties on wet material. The ideal place to use it is where you have a fairly poor quality of rock ballast that is worn out. Put four to six inches of burnt ballast on that rock, and it makes ideal track. I have never seen burnt ballast heave in the winter, and I have never seen it when the water did not run freely from it. I refer, of course, to good burnt ballast.

You can get from three to five yards of ballast from a ton of slack, and you can use old slack or coal refuse in burning, but the better the coal, the better ballast you will get. As a gentleman has said, after the first rainstorm, the dust will not bother you. It never becomes so fine that it is not good ballast; it may be as fine as the end of a pencil, but still be fine ballast and clean. I have never seen weeds growing in it, and I speak after knowing it for ten or twelve years.

It is very easily handled and can be loaded with a steam shovel, and is cheap to transport. Of course, rock is good, but each country is limited as to what it can get, and in some localities there is no rock. In places where there is no gravel, gumbo is nearly always found and sometimes blue clay, which makes very good ballast, as I have stated, when properly burned.

Mr. F. H. McGuigan, General Superintendent Grand Trunk Railway:—I have had some experience with burnt clay, and agree with my friend, Mr. McFarlin, that it is a most excellent ballast, but am not prepared to say that it is the best ballast obtainable. During the years 1887 to 1895, we ballasted 225 to 230 miles of the Wabash Road between St. Louis and Kansas City with burnt clay, making a very good track.

On something over half the line we had a very bad roadbed. The gentlemen present who are familiar with that section of country will, I think, bear me out in saying that the divide between the Mississippi and Missouri rivers is the worst belt of country this side of the Rocky Mountains on which to maintain a track. The material generally is hard clay, so susceptible to the action of water, that it is exceedingly difficult to maintain open ditches, owing to its tendency to slide when wet.

We had little ballast except the top soil along the right-of-way, varying from six to eighteen inches, and a very inferior quality of limestone. We eventually succeeded in learning the process of burning clay for ballast, which after two or three years we were able to produce at about or a little lower than the figures given by Mr. McFarlin, as we purchased our slack coal at 25 cents a ton at the mines. The burning of the first fifty thousand yards contracted, cost us in the neighborhood of ninety cents per cubic yard, but as we learned from year to year how to burn, and the cost of doing the work, we were enabled to reduce the contract price to twenty-one cents per cubic yard, and I believe to-day the burning can be contracted in quantities of say 200,000 to 300,000 yards at seventeen to eighteen cents per yard—not including the slack, of which between 450 and 500 pounds is required for each cubic yard of ballast burned.

On account of the difficulty of maintaining the track we ballasted very heavily, using about 3,000 yards to the mile.

At our contract price in 1895—as I now recall it, twenty-one cents per cubic yard for burning—our ballast cost $1,200 to

$1,500 per mile, in track, complete, according to the distance hauled and condition of roadbed.

During the first two years that we used burnt ballast, in order to get authority to burn more, I frequently said to our people (and then believed it true) that weeds would not grow on it, but I afterward learned that they did grow upon it just as they will upon other ballast in time. Taking everything into consideration, it is by far the best ballast obtainable in that section of the country—in fact, it is the only ballast within reach of the railroads there. I do not, however, regard it as the best ballast for heavy traffic, because, as explained by Mr. McFarlin, of its lightness, weighing about fifteen hundred pounds per cubic yard. You will readily understand that there is not much resistance in such light ballast on an inferior roadbed where the curvature is excessive; hence, we frequently had considerable difficulty in holding the track in proper line.

Since going over on the east side of the Detroit and St. Clair rivers, our experience there has confirmed our previous belief that good gravel is not only the best, but the cheapest ballast on which to maintain a track under heavy traffic. I am sorry to say that I cannot agree with my friend of the Lake Shore that labor is all that is necessary to maintain a smooth track.

In his country, much of the roadbed on which the track rests is sandy soil, of excellent quality, making a fairly good ballast in itself, and requiring very little drainage; hence easy to maintain the track on. The same amount of ballast that would make a perfectly smooth track on the Lake Shore would not come anywhere near making a good track in the section of country between St. Louis and Kansas City, previously mentioned. It would require more than double the quantity of the same ballast to get the same results as on the Lake Shore Road. Therefore, I do not think it possible for this Committee to arrive at or prescribe any fixed quantity of ballast to be used—conditions vary so much in different localities.

Mr. Rockwell:—I do not want Mr. McGuigan to think that I meant that all that is necessary for good track is labor. First of all you have got to have drainage, and next after that I think you have got to have more drainage. If you do not have good drainage to your subgrade or to the groundwork for your ballast, you can not have good track anyhow. My idea of the definition

of a ballasted track is track that has ballast enough so that it will not churn, and we may have a small amount of ballast, or a large amount, according to the character of foundation that we have to put it on. What I said had simply reference to the surface finish of the track.

Mr. McGuigan:—During the summer of 1898, we ballasted forty miles of our line between Niagara Falls and Hamilton with gravel taken from the beach of Lake Erie—directly opposite Buffalo—the percentage of sand in which was so small (possibly fifteen per cent) that it was practically screened gravel. It made a very beautiful track to look at and for a time rode nicely, and is to-day almost entirely free from dust and vegetation; but it has disappointed us considerably, as it does not seem to hold the track in line, nor does the surface hold as well as with most of the gravel which we have loaded from other pits with steam shovel. This gravel from the lake beach, you will understand, differs materially from gravel loaded from the ordinary gravel pit, as it is composed largely of small pebbles with a light percentage of sand, without any bond or adhesive properties such as are found in good, average gravel.

Mr. C. S. Churchill, Engineer Maintenance-of-Way Norfolk & Western:—I am glad that the question of slag has been brought up by the Committee. This is a waste material on many sections and on many roads. We have used it for ballast with great success since 1890. Our road is one which is very plentifully supplied with limestone, which furnishes the best class of stone ballast. Nevertheless, the result of our experience with slag is that it is equal to the best stone ballast. We have sold several crushers, and are largely dependent, therefore, to-day, on slag ballast, of which we have large quantities along the line of our road. It has cost us about twelve cents on board cars. It is put on board cars at furnaces for above cost, delivered on track and put in same complete for a further cost of twenty-five cents per cubic yard; and we get good track, and we think superior track, in many cases, to what we get with the best hard limestone ballast. The advantage of glassy slag for use in ballast, when it is broken up fine, is very great, and we believe that the tendency of the roads will be to use more slag and finer stone ballast than has heretofore been used.

Mr. Stevens:—I think I can throw some light on this

question. We have fifty miles of road that have been ballasted with slag for more than forty years. The traffic has pulverized that slag from year to year, and dust has settled to the bottom, and to-day there are probably six inches to a foot of the cemented slag under those tracks that is almost as hard as stone. We are now ballasting tracks with stone. We have not sold our crusher.

Mr. Churchill:—There are different kinds of slags. There are some furnaces the slag of which we would not use—which it would be impracticable to use. But we have the glassy slag; it is usual to select that slag after the furnace has dumped it. Every furnace has a big output of slag; some is spongy in character and has free limestone in it. This is wholly unfit for use. The furnaces in Ohio turn out slag which we cannot use for ballast. There was some of this slag used for ballast in 1887, which we have been obliged to remove, but we have learned by experience the kind to select and the kind to abandon, and for that reason we know that we have several furnaces that turn out glassy slag, and we feel that we are independent of the use of broken stone. I do not say we have sold all our crushers. We have got a few we keep aside, so that we can use them in case the furnaces decide to charge us a little too much for the slag. Of course, we have got to look out for our interest in that respect, but we had, in 1,600 miles, eight crusher plants in 1887. Since that time we have dismantled a large number of them.

Mr. Stevens:—In this cinder or slag there is no great proportion of free lime, but the continual action of the track tools is perhaps what has caused this trouble. The ballast, when first put on, and perhaps for the first six or eight years, would be reasonably good, but the gradual disintegration for a long term of years has brought about this result. We are unable to use the slag selected on account of the extreme brittleness of the slag. We reject it for that reason.

Mr. W. E. Dauchy, Chief Engineer Chicago, Rock Island & Pacific:—I want to say a word more about what has been said about ballasting, and that is this: In selecting the ground, it usually happens that the gumbo deposits are on the creek bottoms, and the question of drainage during the burning process adds largely to the quality of the ballast we get. It frequently happens, if this question of drainage is not looked after closely, that

during the rise in the streams the pits are flooded, and the fires are put out, and that always results in getting an inferior quality of ballast, and I think that some of the prejudice against burnt clay ballast may be the result of some such experience.

Mr. D. W. Lum, Assistant General Superintendent Maintenance Southern Railway:—I would like, if possible, to arrive at an average between the statements of the gentlemen with reference to rock and slag. We have several hundred miles of slag ballast and perhaps a thousand miles of rock ballast on our line, and we find that the slag ballast does break up very fine under the tamping pick, and frequently collects as a fine powder at the ends of the ties, whereas, the rock does not do so and affords better drainage; and while the slag is very much cheaper and does, for the present, make very good track, it is our experience that the rock is more durable.

Mr. E. F. Wendt, Assistant Engineer Pittsburg & Lake Erie:—Our road uses slag exclusively for ballast. This material is used, not from preference, but rather because slag is given to railroad companies at Pittsburg without charge. In fact, the furnace companies have difficulty in disposing of the slag and are glad to get rid of it for nothing.

In discussing the use of slag for ballast we should keep in mind the fact that the term "slag" means anything from particles of dust to chunks the size of a football. The same blast furnace may make for a time a good hard slag fit for ballast; then again it may turn out slag which is practically dust and unfit for ballast.

Dusty slag will eventually cement its particles together and form a hard crust under the ties, a condition which results in very bad riding track. There is, however, a quality of slag turned out by some of the furnaces making Bessemer iron which varies in size from two to four inches on a side, which makes very fair ballast. When slag of this quality can be procured without cost it would not be economy to purchase broken stone at sixty cents per cubic yard. It must, nevertheless, be understood that slag is very expensive ballast to unload and place under the track, as every man knows who has used it.

After using slag for ten years, our opinion is that it is inferior to broken stone for ballast and a proper gravel is certainly preferable to either stone or slag.

The President: Mr. Lum, what is your experience in reference to using slag for a foundation ballast and covering it with rock?

Mr. Lum:—We have done that in some cases, but wherever possible we are using rock, as we consider it much better.

Mr. Hutchinson:—I believe the Reading Road was the first road to use slag as ballast. In those days, when they began to use it, there was more iron in the slag when it came from the furnace than there is now, consequently the slag was pretty hard and made pretty good ballast, but as furnaces run now, the quality of slag ballast has deteriorated.

Right after my friend Stevens began, they used a smooth kind of slag. By the time we got there, the good slag had been used up for the Reading, and they to-day are using the new kind. We put it in very extensively in 1888, and to-day I think there is not a mile of slag-ballasted track on the Schuylkill Division. They found exactly the trouble that Mr. Stevens and Mr. Lum just described.

Mr. Stevens:—I want to say further that we did not abandon the use of slag on account of any other reason than purely to avoid this trouble, for this furnace cinder did not cost us a cent—the furnace delivered it on the cars to us, to get rid of it.

Mr. Churchill:—Answering the question of the President—I have not had experience with the use of slag over stone. Answering the previous speaker—I think that the whole difference between Mr. Stevens and myself is really covered by the proper selection of the slag to be used.

We have been through the whole matter ourselves, and I also was on the Schuylkill Valley Railroad, and had something to do with the building of it. Further, I am acquainted with the Reading Railroad, and that character of slag we would not use. Therefore, I say, it is a matter of selection just the same as the choice of a gravel pit is controlled by its quality. If you have not the right kind of slag on your road, it should not be used for ballast any more than one should use cementing gravel. However, it is an easy matter to determine the proper slag for such use.

Mr. Wilson:—I think we are probably spinning out this subject of slag ballast unnecessarily. If the Committee, in treating this subject as specified under No. 1, "d," as slag, cinder and burnt shale, will also add as under "a," size and quality, it will

then give these gentlemen more opportunity to agree, as their disagreements seem to be upon these two last points and upon the question of quality seems to depend the entire question as to whether slag should be considered as a fit ballast to use.

The President:—Our time is being used up and while this discussion is very interesting, after calling on Mr. Peddle, we will close the discussion.

Mr. Peddle:—I want to thank the gentlemen for the information gained this morning. After all, the question of standard ballast depends on the payrolls.

The President:—We have four other important committees to hear from, and it will probably take about two and one-half to three hours, and it is now one o'clock. It is a matter that we would like to have the Association decide as to whether we shall take a long recess or a short one. It seems to me that instead of cutting off these discussions, we should have a full expression from all our members. When we get into an interesting discussion, as we have had on this ballast question, we should not be compelled to give it up or to cut it off on account of lack of time. I think it is possible that we could devote at least two or three hours more to the discussion.

The Convention then adjourned until 2:00 p. m.

THURSDAY AFTERNOON SESSION.

The President:—Will some member of that Committee please call the attention of the chairman (who is not present) of the Interlocking Committee to the question of taking up and getting information as to the State laws on interlocking requirements and on grade crossings and signals? It has been suggested and is a very important fact that we have overlooked, that a great deal of committee-work might be thrown away provided it did not correspond to or meet the requirements of the State laws in some of our States, and that the work of the Committee in the compiling of these laws and conditions might enable us a little later on to take up the matter as an Association with the commissions of the various States, so as to get laws that will be uniform and practicable from an operating standpoint.

Mr. D. D. Carothers, Engineer Maintenance-of-Way Baltimore & Ohio Southwestern:—It occurs to me that on account

of the limited time that we have it might be possible to do away with the reading of the papers, as they are now in the hands of all the members, and they have had sufficient time to look them over. I move, therefore, to dispense with the reading of the papers.

The motion was carried.

REPORT OF COMMITTEE IV.—ON RAILS.

To the American Railway Engineering and Maintenance-of-Way Association:

The railroad mileage of this country at the end of the year 1898 is reported at 187,000 miles, with 245,000 miles of track. The expenditure in 1898 on account of maintenance-of-way and structures is given as $160,000,000—about 21 per cent of all operating expenses. The expenditure on account of rail, based on figures for the past five years, would be about $14,000,000. This does not represent the amount paid mills for new rails, as that amount is credited by amounts received from sale of scrap and old rail applied to construction of sidings, etc. It would appear fair to estimate that about $25,000,000 is paid out per year to the rail mills by our railroads.

A glance over the maintenance-of-way and structure accounts indicates that expenditures on account of rails come second to cross-ties, and, taking into consideration the large amount involved, an increase of one year in the life of our rail means a considerable saving. On account of the sharp competition for traffic, low rates, and the necessity of bringing down the transportation expenses to meet the constantly decreasing rates, the rail question may be considered to be one of prime importance.

It is the duty of the engineer to use such materials as shall be economical both in original cost and maintenance. The two items of original cost and maintenance are very closely related. If we now pay $33 for a rail lasting, say, ten years, it is costing us $3.30 per year; if, by paying $34, we could get a rail that would last eleven years, it would cost us $3.10 per year, showing we can well afford to pay the addition of $1 per ton to get an additional year's life. So we see that there is possibly no problem worthy of more attention than the one of economical wear and service of steel rails.

This Committee has received a communication from a member in Canada, asking the help of your Association toward securing better rail. His railroad is buying from the States; the rail is soft and wearing badly. The mills have been asked to give better rail, and the reply is that the railroads in the States are using the same rail, and what is good enough for the States is good enough for Canada. Your Committee is also of the same opinion as the mills, "that rail good enough for the States is good enough for our brother in Canada." Do not our trains run as fast, and are not our engines and carloads as heavy? And this brings the

issue squarely before us: Is the rail now furnished by the mills of the States good enough for the railroads of the States? If this Committee could conscientiously answer yes, then it might congratulate itself on having an easy life ahead; but we cannot, however, concede the truth of the statement that the rail we are now getting is good enough, and we will, therefore, aim to make such practical suggestions or recommendations as shall help toward a solution of this vexatious problem.

It may not be out of place to call attention to the fact that many well-meaning efforts at reform have been in vain, on account of the very radical position taken by some of the persons connected therewith. Therefore, if any of us incline to extreme views in such matters as high carbon or low carbon, let us find at least some common ground on which we can take a stand, and then we shall make headway, possibly slowly, but surely. If we agree on uniform sections on all our lines, we will eventually save for our companies, and, possibly, in addition, increase the profits of the rail manufacturers, about which so much talk has been heard in Pittsburg recently. Let us agree on one other thing—that the mechanical treatment in rolling and the temperature at which the rail is finished is of the greatest importance—then insist on the mills making an improvement in this regard.

If this Association can agree on a specification for the manufacture of rail, which may not be perfect, but which will be a step in advance of what we are doing, have it approved by our companies and accepted by the rail manufacturers, decided progress will have been accomplished. It would appear better that we should attain our goal by making two or three steps, if necessary, as we are able, rather than by trying a big jump and fail.

History.—The Committee deems it proper in this preliminary report to give a brief resumé of the facts in regard to the evolution of our present rail. It is said that railways are as old as civilization, reference being had to ways adapted to the passage of wheeled vehicles. Wagons were used in Egypt at a very early day. No doubt railways or tramways were used in the construction of the Egyptian pyramids. Wooden railways are said to have been used in the mining districts of Germany from time immemorial; they were introduced into England as early as 1602, and to this country we are largely indebted for the development that has taken place.

The wooden tramway was the first improvement over the ordinary road.

1602.—In a history of coal mining at Newcastle-upon-Tyne we find a complaint of "badness of the roads by which the loads of carts were reduced."

1649.—On the authority of Nicholas Wood, who mentions a book entitled "Chorographia, or a Survey of New Castle-upon-Tyne," published in 1649, credit is given to a South Country man named Beaumont, who introduced wagons which ran on tramways. We are told Mr. Beaumont expended thirty thousand pounds in improving ways and wagons, etc.

1676.—Roger North, in "Life of Lord Keeper North," Vol. I., p. 265, states that at Newcastle-upon-Tyne, in 1678, among the curiosities of the place were "Way Leaves," or "Ground Let for Laying Wooden Tramways On." These consisted of single wooden rails of timber, straight and parallel.

1700.—Double wooden rails used; that is, a second longitudinal was spiked on top of first stringer.

1737.—Cast-iron plates used on face of wooden rail to obviate rapid wear.

1750.—Cast-iron wheels in use.

1765.—We hear of regular constructed railways, with special works, cutting and filling, with wooden rails seven inches square, resting on cross-sleepers four feet apart.

1767.—Cast-iron rails first made at Colebrookdale Works, in Shropshire, five feet long, four inches wide and one and one-quarter inches thick, each rail having three holes to fasten. Mr. Nicholas Wood, in his book on railroads, 1825 edition, says: "Mr. R. Stephenson, whose inquiries with railroad conveyances have been pretty extensive, states: 'I some years ago visited the great iron works of Colebrookdale, in Shropshire, where cast-iron was indisputably first applied to the construction of bridges, and, according to the information which I have been able to obtain, it was here also that railways of that material were first constructed. It appears, from the books of the extensive and long-established company, that between five and six tons of rails were cast on the 13th of November, 1767, as an experiment, on the suggestion of Mr. Reynolds, one of the partners.'"

1770.—Wooden rails have rounded tops, with wheels cast-iron, hollow to fit. Outer flanges rejected.

1776.—Cast-iron railway at Sheffield, two flanges projecting upward; both flanges of wheel dispensed with.

1789.—An organic change comes with the Jessop edge rail, so-called from being narrow and deep, which again restored inside flange to wheels. They were cast-iron bars, three feet to four feet long, web one-half inch to three-quarter inch thick, swelling out at head to two or two and one-half inches.

1792.—Chairs for rails appear.

1797.—Plate rail, with flange turned up like an angle; later improved with fish-belly.

1800.—To this date the rails were laid longitudinally on cross-sleepers at intervals of three to five feet. Ostram used stone sleepers instead of wood cross-ties, giving name Ostram roads, after abbreviated tramroads.

1803.—The Surrey Iron Railway, the rails were three feet two inches long, rectangular plates of cast-iron four inches broad on the tread, one inch thick, except for five inches or six inches at each end, where they were one-half inch thick; below was a rib or fish-belly about two feet long for additional strength.

1808.—Malleable iron used at Walbottle Colliery, near Newcastle. One hundred and fifty years of engineering experience required to advance from timber, laid down to prevent wheels sinking into the mud, to an iron rail and iron wheels, something like mode of present day.

1811.—Wrought-iron rails in use.

1820.—The Bedlington Iron Works rolled rails fifteen feet long, after designs by Birkenshaw.

1825.—Stockton & Darlington Railroad opened September. Construction consisted of fish-bellied rails, twenty-eight pounds to the yard; points of support three feet apart.

1831.—Camden and Amboy partly laid with Stevens rail, commonly known as Vignoles, the design being erroneously attributed to this French engineer, who introduced it into England. This rail was rolled by Dowlais Iron Works, Cardiff, Wales, five hundred rails, eighteen feet long, thirty-six pounds to the yard, being shipped to Philadelphia in 1831. This type almost universally used in this country and in Europe.

1835.—Experiments by Barlow led to abandonment of fish-bellied rail in England and substitution of rail with parallel faces.

1837.—Double and equal headed reversible rail, invented by Joseph Locks and used on Grand Junction Railway.

1844.—First rail rolled in America at Mount Savage, Allegheny County, Maryland, being U-shaped, weighing forty-two pounds to the yard, and laid on longitudinal wood sills.

1856.—First Bessemer rail rolled. The behavior of these first rails was unsatisfactory and manufacture was abandoned.

1864.—Manufacture of Bessemer rails resumed.

1872.—Manufacture of steel rails in the United States, largely increased about 1875.

1892.—A. S. C. E. sections adopted by the American Society of Civil Engineers, and may we not add—

1900.—A. S. C. E. sections adopted by this Association?

Sections.—The railways of the United Kingdom are almost universally using the bull-headed steel rail, keyed into chairs fastened to transverse sleepers, while in America we use flat-bottomed rails, resting direct on transverse sleepers.

In a paper reported by William Hunt, Chief Engineer of the Lancashire & Yorkshire Railway, read before the International Railway Convention of 1895, we find the following:

"The Engineer of the Great Northern Railway of Ireland, comparing our American practice with the English, says: 'As the steel rail (American) is immediately in contact with the sleepers, the result is a very smooth-running road; at the same time there is no doubt that our steel bull-headed road, with the chairs keyed inside, is far superior, stronger, more permanent and better, in every way than any flange railroad.'"

The Chief Engineer of the New York Central Road, reporting on the American type to the same body, says: "Rails supported in chairs have

been out of date in this country for many years past, the Vignoles type or flange rail, as it is termed in this country, having proved immeasurably superior in service and economy on American railroads."

The Committee, being of the opinion that the A. S. C. E. sections are a step in advance, thinks that no new sections should be suggested until we have had full time to learn from experience the merits of these sections. It is recommended that all members of this Association, whose lines are not using these sections be urged to have them adopted and used on their lines. The results should be carefully compared with results from the old sections. Mr. Manning writes us that "the A. S. C. E. sections are by far the best, with the exception that the head should be a little deeper for rails under ninety pounds." Of course, you all know that Mr. Manning has a section of his own for curved track, which he thinks can be applied to a straight line also with good results. The percentage of curved tracks on a majority of lines is small, so that, in the opinion of a majority of the committee, no additional sections are needed to meet the situation.

Referring again to the A. S. C. E. sections, we must always bear in mind that the best results from these sections will not be obtained until better work is done at the mills, and this brings us to the chemical constituents and the mechanical treatment, the latter being probably the more important.

Chemical Constituents.—Experiments are being conducted on a small scale with open-hearth nickel-steel, Bessemer nickel-steel, and high and low carbons. These special rails are very high-priced, and, in the opinion of the Committee, are not likely to come into general use—at least for some time. We do not consider it advisable to treat this matter at length at this time any more than to call attention to the fact that in many cases of rails giving good service we have to look beyond the chemical constituents, as we shall see later. Your attention is called to an abstract from the Railroad Gazette of November 24, 1899, on hard and soft, or high and low, carbon rails, as follows:

"Quoting the results of experiments on the Netherlands State railroads, in which sixteen German rails were made from four different charges, two of which contained 0.38 carbon and two 0.21 carbon. After 1,833 days' service these rails were reweighed and the loss of weight in the case of the soft rail was 28 per cent more than in the case of the hard rail. After 3,787 days' service they were again reweighed, and found that the hard rail had lost 14 per cent more than the soft rails, with total results, after 5,620 days and 91,459 train movements, the soft rails had lost four per cent more than the hard rails.

"In addition to this twenty-two Belgian rails were laid, made from six different charges, three of which contained 0.45 carbon and three 0.25 carbon. After 2,040 days' service the soft rails had lost 29 per cent more than the hard rails, but in the next weighing, after 3,635 days' service, the hard rails had lost 5 per cent more than the soft, with a total result that, after 5,675 days' service and 98,938 train movements, the soft rails had lost 7 per cent more than the hard.

"In the first reweighing the hard German rails lost, per metre and per 10,000 trains, 133 grammes, while on the second weighing they had lost only 91 grammes per metre and per 10,000 trains. In the soft German rails these losses were respectively 170 and 80.

"With the Belgian rails, at the first reweighing, the hard rails lost 121 grammes per metre and 10,000 trains, while on the second reweighing they had lost 98 grammes. The soft rails had lost 156 grammes per metre and 10,000 trains in the first period and 93 grammes on the second period."

Attention is called to a paper by one of the members of this Committee, Mr. Hunt, some years ago, in which he brought out the fact that rails with widely different chemical components gave equally good service.

Mechanical Treatment.—The rolling of the rail is of the highest importance. The best American rails appear to have been made about 1880; there was then no good uniformity in chemical constituents of Bessemer steel; it varied widely, but such variation had but little influence on the wear of the finished product. In order to determine why the rails gave good service, we must, therefore, look to the methods of manufacture, and the molecular structure of the steel resulting from these methods.

The following description of the old and new methods, with some deductions, is quoted from a letter of Mr. Reed, in charge of a rail-sawing plant at Wheatland, Pa.:

"In 1880 the usual Bessemer practice was as follows: In the blast furnace, ores naturally low in phosphorus and sulphur were used, the iron was produced much slower than to-day; after being cast into pigs it was allowed to cool—come to rest, molecularly—then selected on its chemical analysis, remelted into cupolas and blown into converters in smaller quantities and also slower than at present, and, it is fair to assume, was more thoroughly 'cooked' and combined with its alloys. The resulting ingots (fourteen inches square) were allowed to cool—to come to a molecular rest—were stripped of their molds, and were then charged into horizontal furnaces, where they were heated much slower than now, and not so hot as present practice compels. When heated they were bloomed down to seven inches square, in thirteen passes keep in per pass through the rolls. These seven-inch blooms were then allowed to cool—come to molecular rest—and then charged into another heating furnace, again being heated more slowly than in present practice, and then were rolled into rails of somewhat less average weight (say, seventy pounds) than at the present time. Using a smaller bloom than now, even though making generally a lighter rail, there was less reduction of work necessary in the rolls, but it was slowly done, as forty-nine square inches of bloom were reduced to a seventy-pound rail in thirteen passes in a train running four hundred feet per minute. As a result of this deliberate and thorough working the steel was never subjected to violence, and was finished cooler, and this had a most salutary effect on its molecular structure."

Comparing this old practice with that now in use, we find as follows:

"In the blast furnaces, ores both high and low in phosphorus are

used—that is, some extremely low and others above the normal, as compensated—and the furnaces are driven at a high rate of speed. The metal, when reduced, is run, fluid, into a 'mixer,' but is never allowed to come to rest or cool. From the mixer it goes, still fluid, to the converter, and is blown hard and rapidly in less time than before and in larger amount. Then it is cast into ingots, which are not allowed to cool or come to rest, but are at once charged into heating furnaces, and held there until ready for blooming. They are then, with their contents in an unknown state—sometimes fluid, semi-fluid, pasty or granular—passed to the blooming mill and reduced from sixteen by eighteen inches (an average, modern-sized ingot), having 288 square inches of area, to a bloom eight inches square, having sixty-four square inches of area, which is a reduction of 224 square inches, in eleven passes, or 20.4 square inches of reduction to each pass (instead of 11.3, as formerly), which is nearly 100 per cent faster, in addition to which the train is nowadays driven at a higher rate of speed than formerly. The eight by eight bloom thus produced is not allowed to cool, come to rest, and readjust its outraged and crushed particles, but is charged into a heating furnace and held hot, or in some cases proceeds without further heating direct to the rail mill, where it is reduced to a seventy-pound rail, in nine passes (instead of thirteen), by rolls running 900 feet per minute, instead of 400, as formerly, which is over 60 per cent more reduction, pass for pass, leaving out of consideration the speed at which it is done, which has an important bearing on the final result. Owing to all this haste the rails finish at a high temperature, and the heads practically anneal and soften themselves on the cooling beds, but the annealing is useless and too late, as the mass of metal in the heads is, of course, open, friable grain and poorly fitted to stand the abrasive action of car wheels under heavy loads."

When steel is allowed to cool without being subjected to work it takes on a coarse, crystalline structure. If it is subjected to work while in the plastic state the crystallization becomes smaller, as the work is done at successively lower temperatures, until we reach the recalescent point.

The main difference between the present and former mill practice in making rails consists in a fewer number of passes and faster speed of train by which the finished pass is reached, while the metal is still at or above an "orange" heat (2,000 to 2,200 degrees Fahrenheit). Whereas, in the older practice, with more passes and slower speed, it was finished at a "cherry-red" heat (1,400 to 1,600 degrees Fahrenheit). The modern rails, as shown under the microscope, have a crystalline structure in the head, which cools last. The larger the section, the slower the cooling and the coarser the crystallization. Rails finished at a dull red heat (1,300 degrees) have a finer granular texture throughout, as shown by experiments made by the Carnegie Steel Company.

It is our opinion that the wearing quality of the rails will be improved by taking more time for the finishing passes at the rolls.

This does not mean that the speed of the rail mill need be reduced,

but that provision be made for holding a number of rails at a certain stage in the rolling, allowing them to come to a certain temperature, which will also mean that the heat retained in the rails will be distributed uniformly throughout. The rails are then taken in the order in which they have been held, and the finishing passes are taken at a lower temperature than present practice. Your Committee understands that patents have been taken out, covering this improved method of rolling, and that in the near future we may expect rails with more work on them, insuring a better wearing surface and a better wearing rail.

Length of Rails.—There is probably more diversity of opinion at the present time on this point than any other. We have been advocates of 30-foot, 33-foot, 33-foot 4-inch, 45-foot and 60-foot rails.

The transportation difficulty has been the governing feature in fixing at thirty or thirty-three feet, the latter being considered the longest rail that can be handled conveniently in present length of cars. The advocates of forty-five foot rails think forty-five feet about the maximum length that can be used with reasonable close-joint spacing. Then we have the sixty-foot rails, taking out 50 per cent of our joints.

It is the experience of a part of the Committee that sixty-foot rails can be laid with most excellent results on lines of easy grades and light curvature, with joints much closer than used in the average practice. It is believed that the best results will be obtained with sixty-foot rails when anti-creeping devices are used at least every thirty feet.

The care of rail in laying, and after laying, although of very great importance, is possibly second to some of the items mentioned.

Thousands of tons of rail have been taken out of the track after short service on account of battered ends, due to improper and wide spacing at joints. If your track is well and full ballasted there is little trouble to be anticipated by laying pretty close joints. If, however, you lay close joints and have your track half or quarter ballasted, look out for bad results in very hot weather.

These matters will receive more attention from the Committee at a later time.

Specifications.—The Committee will recommend to your Association a standard specification for general adoption.

In Conclusion.—The very complete syllabus prepared for the Association fully covers the ground, and the Committee has nothing to suggest in addition to that syllabus. The Committee has given some thought to the manner of laying rail, use of relieved rail, etc., and these matters will be brought to your attention in future reports.

R. Trimble, Principal Assistant Engineer Pennsylvania Lines West, Pittsburg, Chairman;

S. M. Felton, President Chicago & Alton, Chicago, Vice-Chairman;

A. W. Johnston, General Superintendent New York, Chicago & St. Louis, Cleveland;

Thomas Purcell, Superintendent Mexican National Railway, Matamoros, Mex.;

W. T. MANNING, Consulting Engineer Baltimore & Ohio Railroad, Baltimore;
C. E. WICKHAM, Division Engineer Chicago, Rock Island & Pacific, Chicago;
R. W. HUNT, Consulting Engineer, Chicago;
J. H. WALLACE, Assistant Engineer Maintenance-of-Way Southern Pacific, San Francisco;
G. B. WOODWORTH, Rail Inspector Chicago, Milwaukee & St. Paul, Chicago;

Committee.

The President:—The Rail Committee is represented by Mr. Johnston, Mr. Hunt, and Mr. Woodworth, and as we may want to ask this Committee questions, and it must have a head, in the absence of its chairman and vice-chairman, we will place the Committee in charge of Captain Hunt. The subject is now open for discussion.

Mr. E. E. R. Tratman, Resident Editor "Engineering News":—I would like to make a suggestion as to historical record, under date of 1831. It has been said that the Stevens rail is the invention of a French engineer, Mr. Vignoles. I think it has been pretty thoroughly proven, authoritatively, that Col. Robert L. Stevens invented that in 1830. The rails were rolled in 1831, and it was not until 1836 that Vignoles brought out his rail. He may not have known of the Stevens rail, it may have been simply a reinvention, but I think that the paragraph should be revised to give Stevens, the American Stevens, the credit for that rail. At the end of the historical record, also, reference is made to the adoption of standard rail sections by the American Society of Civil Engineers. As many of us here are members of that Society, it is hardly necessary to state that the Society has no standards, for rails or anything else. The sections referred to were recommended by the Society's Committee on Rail Sections, in its report in 1893, and the report was accepted by the Society. That Society may recommend certain practice, but does not adopt standards.

The President:—I presume the first question you will want to ask Captain Hunt is, "Why do we not get better rails?"

Mr. P. A. Peterson, Chief Engineer Canadian Pacific:—I wish to ask Captain Hunt a few questions. I would like to know

why we do not get as good rails as we did in the olden days. We have fifty-six-pound rails in our road that were laid in 1875, of which there have been very few broken, and we run our heaviest engines over them at sixty miles an hour. I would like to hear from Captain Hunt why these rails are better than those we get at the present day, weighing eighty pounds to the yard.

Captain Hunt:—I think I have gone on record so many times as to my belief covering the causes of the present heavy section rails being unsatisfactory—that is, comparatively unsatisfactory—and why the modern rail does not give as good results as you obtained from the original steel rails or those made in the earlier days of the Bessemer manufacture, that it seems to me anything I should now say would be trite. At the same time, if you will allow me, perhaps some of you gentlemen do not know that it is my fortune to have been connected with the manufacture of Bessemer steel ever since it was introduced in this country, and my living for a great many years has been made in connection with it. Naturally one takes particular interest in the sources from which their bread and butter is derived, so that, if no other reason, has caused me to study the steel problem.

The effect of work on steel is absolutely regulated by the heat condition of the metal when it is performed, so it is easy to appreciate why a rail made under existing conditions should not be the same as one made in the past, even though the composition of the steel be the same.

I suppose all of you are familiar with the experiment, and if you are not, I ask you some day to amuse yourselves by trying it, by going into a blacksmith shop and taking a bar of steel—have the smith put it into the fire and bring it up to as high a heat as that piece of steel will bear. Naturally, the end of the bar which is in the center of the fire will be hotter than as it goes up toward his hand at the other end. When he brings it out, if he will quickly mark it every inch with a nick, and then lay it down and let it cool, and when cold break it at those nicks, it will give you a very complete record of the heat to which that steel has been subjected. It will not have received

any work or been influenced in any way excepting through the temperature to which it has been exposed. You will find that a piece of fine-grained has been changed to a coarse-grained steel, and it will gradually approach its normal condition where it was not heated at all. There is the whole secret. If you form a piece of steel into a rail and perform work upon it at a very high temperature, you are bound to have a coarse-grained piece of metal, and it goes without argument that a body of steel so constituted cannot resist abrasion as well as close-grained. It cannot resist any kind of strain as well as one where the crystals are minute, and, hence, more closely allied and stronger in their character. Under the old conditions the word "steel," as applied to a rail, carried with it the same intimations, or the same controlling influence on the worker that he had been accustomed to consider in the handling of the old grades of steel. It was supposed that Bessemer steel would not bear a high heat. Steel rails were rolled, originally, in rail trains, which had been used for making iron rails, some little change being made in the grooves in the rolls. The reduction was made on the same sized trains, the same sized engines—all machinery just the same. They thought they could not heat rail steel to a high point. The practice used to be that before the steel blooms were charged or put in the furnaces the doors of the furnaces were raised, and the interior of the furnaces brought down to a low heat. Then the temperature was increased very gradually, quite an hour and a half being taken in bringing the steel up to a heat sufficiently high to permit of its being rolled, which was not much hotter than those rails that you saw yesterday drawn from the furnace of the McKenna mill. Then, with some thirteen to fifteen passes through the rolls, the reduction was performed very slowly, very carefully. If there was a flaw discovered, the process was interrupted—the flaw chipped out. One man held the chisel with a long handle, while another man with a sledge would strike. He would go to the bottom of the flaw, and then the rolling would be resumed.

Now, this work being performed by this comparatively weak machinery, the result was that the rolls were constantly breaking and there was not the power required. The natural thing was to find out whether the steel would not bear more

heat, so that it would not be so hard, and thus roll easier, and to the surprise of the manufacturers it was discovered that it could be brought to a heat that would almost allow the cinder to start on it, and it would not go to pieces.

We will assume there were seven or nine blooms placed in a heating furnace. I have seen, many and many a time, that the bloom next to the fire would be brought out when it would be so hot that when we made the first pass at the rolls it would go almost into powder. It would crumble up like sand, and you would have to take it up with a shovel. The heater would then take another bloom from the other and cooler end of the furnace, and, if it rolled, he would work from that end back toward the hotter one.

This experience led to the general practice of working the steel as hot as it would stand. Heavier machinery was gradually adopted, but with its introduction the number of reducing passes were lessened. Experience proved that too highly-heated steel gave bad rails, and therefore nearly the original care was given. But then came competition. The railroads, through stress of hard times, reduced the size, or absolutely cut off their orders. So came the desire, the necessity, for cheapening production. This went on during dull times, and when the rush came, through brighter business conditions, volume of production was the thing most considered.

As you have increased the section, so have you increased the effect of heat. If you keep on, you will presently have a piece of steel in your rail head that is in character no better than the old 7x7-inch bloom, from which your original good rail was rolled—a different shape, but absolutely the same as to the physical character of the metal itself. Now, it is impossible for that to give as good results. How it is going to be altered is not as easy a question as perhaps might be thought by one who has not had experience in the matter. You, gentlemen, or at least those of you who control your appropriations, have seldom shown a willingness to pay any more for a rail because there was a supposition that it would prove to be better. Many times twenty-five cents a ton has thrown the work from one place to another. There was a little while that more money was paid for supposed extra quality of steel. That lasted, I think, for one or two orders. Competitors came in and said

they would make the same kind of steel at the market price. Their word was taken before enough of the special rails had been rolled to give a fair trial. The cheap prevailed. So the manufacturers have not been entirely to blame. Notwithstanding the wonderful profits which we have been reading of in the newspapers, of one organization at least, I know there was a time when money was not generally made in the steel-rail manufacture in this country. The best evidence of that is the wrecks that we find scattered along the way—the millions of dollars that were lost in the industry.

Now, if you will for one moment reflect on the conditions to-day: From the time that the ore and the fuel and the limestone are charged into the blast furnace until the rail is put on the cars—at least until after it leaves the straightening press—the metal has never become cold. It has not had an opportunity to cool, so that Mr. Whittemore's statement that the metal is squirted through the rolls is not so far off the truth, because there are thousands and thousands of tons of rails rolled in which the metal has scarcely solidified before the final passes in the rolls.

We can recommend specifications for your adoption, but what good is it going to do, unless there is a concerted movement on the part of the purchasers of the material that they will insist on the specifications being adhered to? If they are convinced that they are good ones, and if it is logical and true that following them will legitimately increase the cost of manufacture, the railroads of the country ought to be willing to pay the proper price for the rails. This would be only fair to the manufacturers.

But I think myself, as intimated in the present report, that it can be brought about without any great increase of cost. The Committee contend that the makers can do it without going to great expense in the reorganization or organization of their plants—for instance, to regularly practice that which has experimentally seemed to have accomplished good results; that is, that after the rail is practically formed, before it gets its last work, that it shall be held long enough in its partially finished condition to lose sufficient heat so that the last reductions will be given it at a low temperature.

All we can do, gentlemen, I think, is to formulate good specifications and submit them for the consideration of this organization and its indorsement, if we can convince you, and so bring its pressure to bear upon the commercial conditions of the matter. You will recall that it took five years for the American Society of Civil Engineers to agree upon the rail sections, which are practically the standard to-day. It is not likely that our specifications can be drawn up in a short time, but in my opinion it is a legitimate and important matter for our organization to pass upon.

I am a member of an American organization which is seeking to agree upon specifications of all kinds to submit to an International Association as American specifications. I have taken the position that (as unfortunately the organization to which I am now alluding is composed almost entirely of the representatives of the manufacturers of the country) they are not the people to put before the world what are thought to be the specifications representing the American ideas and American desires. It is right, of course, that the manufacturer should not be ignored. It would be foolishness for a man to design a locomotive, no matter how proficient he might be in the higher mathematics, and not consult an experienced mechanic in regard to its details; and so it would be very bad judgment to prepare specifications for the manufacture of any material and not take the manufacturers into consultation. You should know just how your plans will affect the cost, and you ought to be frankly told why it is going to increase the cost if it will do so; but I say, the users of material should be the ones who should specify. If you buy a suit of clothes, you do not want to take homespun if you think you can afford to pay for broadcloth. So I do not think the buyer should be absolutely controlled by the man who has the material for sale. I think, in the case of the buyer of steel rails, he should have the right to say what he wants, pay what they are worth, or else leave the details of their making alone and cease complaining.

Mr. Peterson:—It seems to me that this Association can do a good work in organizing a means of controlling the manufacture of a great majority of the things required on railways, such as rails, joints, spikes, tie-plates, etc., etc.

At present the manufacturers control the railway officials, and we have to take what they are prepared to give us. If we hand the manufacturers a specification of what we want, they tell us plainly that they will not work to it, and that we must take what everybody else is taking, or go without it.

In order to overcome this, we must agree upon specifications, and then we must stand together and all refuse to take any articles that are not up to the requirements of our specifications.

I can quite understand the manufacturers refusing to work to as many different specifications as there are railways in the country; but, if we can all unite on one specification, we shall certainly be able to get what we all want, and to get rails made of the best materials, and with sufficient work put upon them, so that they will, at least, equal the rails that were rolled twenty-five years ago, and are still rendering good service in our railways, while rails that were rolled last year are being taken out of the track on account of splitting, flattening and crushing. Many of us have tried to get the manufacturers to give us better articles and have failed; but, if we can all agree as to what we want, we shall surely get it—and this I consider should be one of the principal aims of our Association. It will enable us to meet the manufacturers on even terms, and there is no question but that, if we all unite, the manufacturers will have to come to our terms.

The President:—Mr. Peterson is right. The situation is very much like that presented by the waiter girl in the country hotel, who said to a guest, "Will you have tay or coffee? We have no coffee—you will have to take tay."

Now, we have to take the rails the manufacturers choose to give us, and if we make specifications, as Mr. Peterson says, for one road, and our manager attempts to get the steel company to accept them, they will not do it, and there is no way of making them do it. In union there is strength, and that is the strength of our organization. One reason why this Association put Captain Hunt on this Committee was that he could advise with us. We have to pay him for inspecting our rails, anyway. He can tell this Committee and advise this Association what is practicable for the steel manufacturer to furnish, and about how much it would increase the cost, so that we would not simply get up a scientific theoretical specification that the manufacturers did not

have the ore or the metal to fill, or which was impracticable to work under. What we want and what we need is the best product that we can get from the steel rail mills at an economical cost.

We would not be warranted in paying $100 per ton for steel rails that last twenty-five years if we can get steel rails that will last twenty years for fifty dollars a ton, or that last fifteen years for twenty-five dollars a ton. It is economy that we are after. If the poorer article is more economical for several years, though maybe it is not technically the best rail, it is the economically best rail that we want.

Mr. McFarlin, Chief Engineer Delaware, Lackawanna & Western:—Mr. Hunt seems to criticise the mechanical part of the present rail construction. Does he also criticise the chemical construction?

Mr. Hunt:—That will be governed largely by geographical conditions. It is perfectly easy for the manufacturers east of the Allegheny Mountains to give a low proportion of phosphorus, and it is impossible for those west of the Allegheny Mountains; that is, taking as an illustration Scranton and Harrisburg as two manufacturing points. Their cheapest ore comes from Cornwall, Pa., and therefore they use pig-iron from there. It is cheapest, and it also happens that the ore is low in phosphorus, hence they can give a steel specification where the phosphorus is limited to .05. When you go West, where Lake Superior ore is largely depended upon, it is an impossibility. There are low phosphorous ores in that region, but they are scarce. There is no supply to meet the demand. It would soon be exhausted, and the commercial state of the question to which our Chairman alluded comes in.

Answering Mr. McFarlin's question more directly; under present conditions, where the physical details cannot be controlled, I think the chemical results are of great importance, much more so than if you could control the physical features. The very good rails that have been referred to had no chemical properties that would bear scrutiny at all. When they were made the laboratory did not give the minute determinations which we are able to get at the present day; manufacturers did not know and could not get them. I venture to say that those rails that you had which gave such satisfactory service had from three-tenths

carbon up to seven-tenths carbon, and the phosphorus would run from .04 to one-tenth per cent, and the manganese almost anything, but generally quite low. So if we could get steel treated physically in the way it ought to be, the chemistry would lose its great importance. As long as we cannot do that, then the important thing is to control the chemical composition of the steel. It will never give as satisfactory results, but you have those two horns of the dilemma to consider.

Mr. D. D. Carothers, Engineer Maintenance-of-Way Baltimore & Ohio Southwestern:—I would like to ask if they use nickel steel rails to any extent in the East?

Mr. W. C. Cushing, Engineer Maintenance-of-Way Pennsylvania Lines West:—A limited quantity of nickel steel rail has been used on the Cleveland & Pittsburg Division of the Pennsylvania Lines, west of Pittsburg, on a five-degree curve, but the length of time in service is too short to give results at the present time. It is certainly lasting a great deal better than the other rail, and only time can prove its superiority over the common rail. There is hardly any appreciable wear at all in two years' service.

Mr. S. P. Hutchinson, Assistant General Agent Pennsylvania Railroad:—The rail Mr. Cushing speaks of has been in service on the Pennsylvania Railroad system longer than any other rail that they have of that kind. I believe there is a little on the Horse Shoe Curve that has been in a very short time. I do not think they have gathered experience so far.

The President:—I would like to ask if any member has had any experience—if not, Captain Hunt can tell us—in the use of high carbon rails for frogs and switches.

Mr. Hunt:—Yes; there have been quite a number, quite a tonnage. I think they have given very satisfactory results; so I have been told by the engineers who have used them and with whose practice I am acquainted.

I think certainly that is the place to put harder steel. Taking second-quality rails and cutting them up to make frogs and switches does not seem good judgment—that a piece of steel that has not worked satisfactorily should be required to do the hardest duty that can be required of steel rails. I certainly should not take it. The rail was defective, either because the ingot had mechanical defects, or the chemical composition was wrong, or because the steel was overheated. It does not seem quite logical to choose weak sisters to perform big brothers' work.

In regard to chemical composition, I think a very few years is going to see a radical change in the manufacture of steel. As you probably are aware, the Tennessee Coal & Iron Company are putting in a rail mill to make rails from basic steel metal, and if the Talbot process, which is now said to be in successful operation, is all that is claimed for it by Mr. Percival Roberts and Mr. Talbot, I think the day will come quickly when the Bessemer converter will to a great extent be relegated to the background. This seems almost impossible, but when we consider what a very large percentage of the available ores are non-Bessemer, through their high percentage of phosphorus, and know the evolutions which have taken place, and have led to developments by which man has been enabled to take advantage of that which nature has provided, it does not seem so strange. By the Talbot process you can get a continuous flow of steel, just as you do from the Bessemer converter. This is necessary for the economical operation of the rail mill.

Now, if this comes about, as I believe it will, it will take away the phosphorus nightmare, and you will get your steel so that the carbon may be well up toward 1 per cent, and still have a safe rail.

Mr Peterson:—Will that make a good rail without a great deal of work?

Mr. Hunt:—I think you will never get away from the advantage of the work itself on the steel in the rail.

Mr. McFarlin:—What is the highest carbon in the Bessemer roll now that you find?

Mr. Hunt:—You know the manufacturer's standard—that is, the specifications of the Western Rail Makers. They have agreed on common specifications—some of their details are different from those used during the last few years. This does not affect all of the Eastern railroads, as they can obtain rails made according to what are commercially known as the "New York Central Specifications." Under them they can obtain steel high in carbon and low in phosphorus. The Western Specifications in 80-pound rails give carbon .43 to .53, phosphorus not over .10. The New York Central for the same weight, carbon .55 to .60; phosphorus not over .06. In Eastern practice the carbon frequently goes to .63.

We must not lose sight of safety, and therefore the drop

test should not be eliminated. We must not get rails so hard that they will be unsafe for traffic, but my experience is, and I believe it will agree with that of those who are in actual contact with maintenance-of-way, that there is scarcely ever a broken rail whose failure is not accounted for by a physical defect. Once in a while you get a mysterious break, but as a rule there is disclosed an interior pipe in the ingot, or a flaw or crack which started some time before the break. I think such cracks often come from injury done to the metal under the straightening press, where the rail was not handled correctly.

The workman is paid by the ton—but a few cents—still his aggregate is good, as he is paid on total product—so it is only human that if he can get his work accepted, as it leaves his straightening press, his individuality ceases and he is content. The rail is soon loaded on the car and gone. It may ultimately break from the unduly hard blows to which he subjected it, but his agency will be unknown.

Mr. M. H. Rogers, Chief Engineer Denver & Rio Grande :— This Association can bring to bear upon the manufacturers an influence that will induce them to make rails according to specifications prepared by those who use the rails. I think that we can, through our general managers and presidents, render our exertions along this line effectual, and that we should do so. It will increase the efficiency and life of our rails, and our Association can in that way accomplish a great deal of good. Our President has also referred to a point that, to my mind, does not, as a general thing, have the thought and care given to it that it should have. That is, it is not always the best article—not always the highest-priced article—that is really the most economical. I think we should at all times bear in mind that the best and most economical article—whether it be rails or ties, or whatever else you please —is that which gives the most wear for the least money, provided that we do not disregard the question of safety. Safety must be pre-eminent and should have the most weight in all cases. It is possible that one specification for rails would not fit the mills of the entire country, but there would have to be one specification for the use of the mills east of the Alleghanies, and one for the use of the mills west of the Alleghanies. But I have no doubt that the Committee will carefully consider that question.

The President:—There are other points in this rail matter. After we get our rail, we have got to transport it, unload it, put it in the track, repair it, take it out again, and do all sorts of things with it.

Mr. Dauchy, Chief Engineer Chicago, Rock Island & Pacific:—I think the economical length of rail should be considered along with the other matters.

Mr. Carothers:—Mr. President, I observe in the report of the Committee that they have taken up a matter of vital importance, as I consider it, in handling the rail after it has been received on the road—that is the question of spacing. With the heavy, concentrated loads that are now passing over all lines of railroad, it is of great importance that the ends of the rails should be as close together as practicable. I see they have touched upon that and they are not in a position, I presume, to recommend any special spacing. With our company, we have been using thirty-three-foot rails, and in warm weather, where our track was full ballasted, we have practically laid them with close joints. Of course, if the ballast is scarce, it is a dangerous way, because the heat will expand the rails so as to throw the track out of line, but this will not occur if the track is full ballasted. That is an important point, I believe, to be considered.

The President:—On the Illinois Central Railroad our practice for some years back has been to lay our rails at one-half of the old theoretical expansion. On recent work we have followed the same practice that Mr. Carothers has in warm weather. The old idea used to be that the expansive power of metal was something that could not be controlled. We now find it simply a question whether the track is so constructed and the rails so controlled that you can retain the expansion in the metal itself. If I am not correct in that, there are a great many members here who are competent to correct me, but that is the theory we are working on in reducing the amount of our expansion, for the reason that the wear and tear of our joint is largely because of the opening, and the closer we can keep the rail together the better and the more economically we can preserve it. The possibility of doing that was brought forcibly to my mind because of the fact that for years I have noticed that, no matter how carefully you might lay the rail over a hilly country, you will find sometimes, for one or two or three miles, in a sag, there will be no

expansion whatever. We are able to retain that expansion in the rails themselves, and we have been doing that for years, while at the top of the hill, at the end of the grade, the expansion will be excessive, and we have to close our rails up in order to reduce the expansion.

Mr. McNab, Assistant Engineer Grand Trunk:—Mr. President, if I understand rightly, a few years ago the Michigan Central Company laid some portions of its road with certain lengths of continuous joints, and for information I would like to know if it was an experiment, what the general result was; the Chief Engineer will no doubt be able to give some particulars.

Mr. A. Torrey, Chief Engineer Michigan Central:—In 1893 I brought a lot of rails together, individual rails. As I remember it, on one side I had a built-up rail 800 feet long, and on each end of that 800-foot rail I left a rail 100 feet. On the other side I had one built-up rail 500 feet long and on the other side, in juxtaposition to that, two rails, at each end of that, 250 feet long. Those rails are in that same condition now, with this exception, that in the 800-foot rails the expansion increased a little too much and we cut that down to 500 feet and made the expansion joints about opposite each other. I found that the expansion was quite a feature in that, and that if the tie was jammed to the spike it moved right along without kinking out the rail. It wouldn't seem to affect the expansion that would occur between the morning and noon of a hot day. I used the data I got from daily observation of that rail to get up expansion allowances for the road, which I use now. I have the foreman determine what the temperature of the rail is by leaving his thermometer in the gravel alongside; but first I gave it by instruction, and the way the foreman did that was to keep the thermometer in his pocket. The result of it was that one summer, in 1896, I compared the size of the shim I used, determining it by the exposed thermometer instead of by a shaded thermometer. I found there was 25 or 30 per cent less expansion than I had been previously allowing. My aim was to have the rails touch without particular pressure at 120 degrees in the sun, and have the expansion go by the rail. The largest shim I used was 3-16 inch. The trouble I found, and of course everybody has, was that, although I would lay it that way, I couldn't keep it up. In some places where the track ran together I cut out pieces of rail from time to time. I don't think,

in the manner the President was speaking of, you can lay more than 10 or 20 rails together on a hot day without taking some out. For a year I took observations of the behavior of that rail daily, one at 7 o'clock in the morning and one at noon, and I found there was no movement in the rail from the time that the thermometer got down to 20 degrees Fahrenheit until it got to 20 below zero, during a stretch of temperature that varied 40 degrees. The earth didn't move at all. I don't know why. I can't suggest why it didn't, but it did not. But it was very sensitive to temperature that ranged between 20 degrees above zero Fahrenheit and 125 degrees. I think that is the highest ever recorded. The temperature was ascertained from a thermometer embedded in a piece of rail alongside of a rail; this was covered with a metal slide. The temperature was observed daily and a record of the amount of expansion made. The joints of that rail were pretty near as good as when put in.

The President:—Have the members any further remarks to make? Of course, we realize that we don't expect to exhaust the subject at this meeting or the next or in our lifetime, but we are simply laying the foundation now for our future work, and I presume at the next meeting the Committee will not be still "fuller" than they are now, but that there will be more of them present, and that they will continue the consideration of this matter.

I will, therefore, excuse them and call the next, Uniform Rules, Organization, etc.

Gentlemen, I take pleasure in introducing Mr. Carothers, Chief Engineer of the Baltimore & Ohio Southwestern Railroad, as chairman of this Committee.

REPORT OF COMMITTEE XII.—ON UNIFORM RULES, ORGANIZATION, TITLES, CODE, ETC.

To the American Railway Engineering and Maintenance-of-Way Association:

The work before this Association is so great that no member should shirk the responsibility that membership in the Association implies. Each member has a duty to perform, and the more vigorously it is done, the better the result for both the Association and individual members.

The railroads of the whole country are sure to derive great benefit from the work of the committees, if the work is carefully done, even before final action is taken by the Association. The appointment of the

Committee was so recent that it has precluded any meeting or work before this meeting of the Association. It was my desire to have at least one meeting of the Committee over which I have the honor to preside, so that I could express at this time their ideas as well as my own.

The Board of Direction has requested me, as chairman of the Committee—"No. XII, Uniform Rules, Organization, Titles, Code, Etc."—to prepare a short paper outlining the work of this Committee for future consideration.

I hardly know what can be said in a short paper which will enlighten the Committee or the Association, for the field is so large and the interests so varied that it will require much time and careful consideration to formulate, even in the most general way, an organization or rules which can be applied to all railroads in this country. That the Committee may be enlightened as to the views of the members representing many railroads in all parts of the country, I hope that each one will give us his views by a full discussion of this subject, so that our work may be done on lines that will meet the approval of the Association at the next meeting, when our report is presented. Each member of the Committee is expected to render all the assistance he can in preparing this report.

The Committee should meet at least twice before the next Association meeting, at the headquarters of the Association, or such other place as may be convenient. I favor headquarters for the reason that we can have the Secretary, and all papers of the Association for reference. The work of the Committee should be conducted on the lines of the committee-work of the American Railway Association, and it will be necessary to consider carefully the actions of that Association in our work, so that our recommendations will not conflict with the very valuable work of that organization.

The proper organization of a "Maintenance-of-Way Department" is the first subject given to us.

The second subject is "Code of Titles," applicable uniformly over the entire country.

The two subjects can be considered together, quite as well as separately.

Proper organization is absolutely necessary for efficient service wherever human agents are employed, and this is especially emphasized in the maintenance-of-way department, as the work of that department is scattered over the entire road, and there are so many different kinds of work, each kind requiring a skilled man in charge, and all having ready access to the head of the department, that it will, I am sure, require no argument here to convince this Association of the necessity for a proper organization. There are many things to consider in undertaking to establish a uniform organization that can be applied to all railroads represented in this Association.

1. First, and probably the hardest to overcome, is prejudice in favor of each railroad's present system, for it is evident that their present system has been established after careful consideration, and each man in charge, introducing the system, always feels that it is the best adapted to his line.

2. Economy of operation on some railroads will compel them to do with a much less expensive organization than others. This, however, can be overcome much easier than the first.

3. The difficulty of adapting an organization to railroads of unequal length and importance.

4. On some railroads the organization is provided for in the by-laws and it would be much trouble to change them.

Code of Titles.—I believe a general organization, with uniform titles, can be arranged that will in time be adopted by all the railroads of this country; at least, it is the duty of the Committee and of the Association to recommend what they consider the best, and leave the rest to the railroad companies.

Titles are not so essential, although proper titles play an important part in organization of the department, and should be considered with that subject. The title of an officer should, so far as possible, indicate the position he occupies with the railroad company, and the service he is expected to perform.

Trusting that the Association will be liberal with criticisms, I submit the following rough outline of a "Proper Organization of a Maintenance-of-Way Department," not with the authority of the Committee, but merely to get the views of the Association, to assist in getting our work started.

Chief Engineer.—The Chief Engineer should be the active head of the department, and he should be so fortified with assistants that he will have ample time to investigate all important subjects pertaining to the department; visit other railroads in this, as well as in other countries, so that he can adopt for his company the very best methods practiced on the best railroads in the world.

Principal Assistant Engineer.—The Principal Assistant Chief Engineer will report to and represent the Chief Engineer, and perform such other duties as may be assigned to him.

Bridge Engineer.—The Bridge Engineer will report to the Principal Assistant or Chief Engineer, and will have charge of the designing of all bridges, trestles, culverts, etc. He should inspect all important structures as frequently as possible, to see that they are properly maintained.

Signal Engineer.—The Signal Engineer will report to the Principal Assistant Engineer or Chief Engineer, and will have charge of the designing and installing of all interlocking plants, automatic block signals, highway-crossing alarm bells, and all other special signal work.

Architect.—An architect should have a place in the organization and should report to the Principal Assistant or Chief Engineer. He will design and superintend the erection of all important buildings.

Real Estate and Tax Agent.—The Real Estate and Tax Agent will report to the Principal Assistant or Chief Engineer, and will have charge of all real estate and right-of-way of the company, and see that the property is properly returned for taxation.

Superintendent of Telegraph.—The Superintendent of Telegraph will have charge of the construction and maintenance of all telegraph

and telephone lines, reporting to the Principal Assistant or Chief Engineer on all matters pertaining to said construction or maintenance.

Engineer Maintenance-of-Way.—The Engineer Maintenance-of-Way is really the working head of the department. He will, in a large measure, be the real head, as he will have charge of all classes of maintenance work, reporting to the Chief Engineer.

These seven can be considered the staff of the Chief Engineer, and this staff may be enlarged by such officers, as electrical engineer, etc., and all the above to be supplemented by Assistant Engineers, draftsmen, inspectors, clerks, etc., as circumstances may demand. Roads of short mileage or light traffic may dispense with part or all of the above officers, except the Chief Engineer, who may be able to perform all of the duties outlined above.

The organization from this point to the most subordinate position can be applied the same for all railroads, whether large or small.

Division Superintendent.—The Division Superintendent should be the general manager of his district. I mean by this that he should be in full charge of all departments. In maintenance-of-way matters he should report to the Engineer Maintenance-of-Way, or the Chief Engineer, as the case may be.

Division Engineer.—The Division Engineer should be the Engineer Maintenance-of-Way for his division, in charge of all maintenance-of-way work, and report to the Division Superintendent.

Assistant Division Engineer.—Each division should have at least one competent Assistant Engineer. He should be a man of practical experience, able to look after all the work during the absence of the Division Engineer, superintend the erection of any structure, make surveys, and do any work the Division Engineer or Division Superintendent may require.

Track Supervisor.—The Track Supervisor will report to the Division Engineer and should have charge of such number of miles of road so that he can give his personal supervision to all important work on the part of the road of which he has charge. Each part of the road so divided should be numbered and known as a district.

Track or Section Foreman.—The track or section foreman will report to the Track Supervisor, and the track of which he has charge will be numbered and known as a section. He should have charge of only so much of the road as he can keep in proper repair. This will be governed by the number of tracks and the traffic over them.

Extra Gang Foreman.—The extra gang foreman will do such important work on the district as may be assigned him by the Supervisor.

Water Supply Foreman.—This foreman will report direct to the Division Engineer, and will have charge of all water stations within certain defined limits, keep up repairs, see that all stations are supplied with fuel, that the pumpers are on duty and water is always ready for the locomotive when it arrives at the water crane.

Foreman of Structures.—There should be at least one gang of skilled carpenters, with a competent foreman in charge, on each division,

to keep in proper repair all buildings. He will report to the Division Engineer.

At least one bridge foreman, with a gang of carpenters and laborers, should be located on each division, to keep in repair all bridges and trestles. He will report to the Division Engineer.

At least one foreman of masonry, with a gang of masons and helpers, should be located on each division, to keep in repair all masonry. He will report to the Division Engineer.

Supervisor of Signals.—The Division Engineer should also have a Supervisor of Signals, who should look after the repairs of all signals on his division.

In the foregoing rough outline I have indicated in some instances some of the duties of the position. This does not belong to the organization, as I view it, but to the rules and regulations. As I understand the work of the Committee, it will be very difficult to consider the subdivisions separately. Before any rules can be formulated intelligently we must establish our organization, so that we may know to whom the rules apply.

The Committee should carefully examine all books of rules now in use governing maintenance-of-way departments, also the code of the American Railway Association, and then try and formulate only general rules that can be adopted by all railroads. To do this it will be necessary to follow the present general practice, so far as possible. After the rules have been adopted on a few of the larger systems, changes can be made as circumstances demand, the same as train rules are constantly being changed by the American Railway Association.

Code of Maintenance-of-Way Ethics.—After our organization has been completed, and our rules adopted, the code of ethics of the maintenance-of-way department, as applied to each railroad, will be pretty well established. I think the relations existing between the different maintenance-of-way officers is quite well understood at present, and I do not care to introduce that phase of the subject until we have gotten through with some of the other more important work.

We hope the Association will be kind enough to us to enter into a full discussion of all the work laid out for our Committee.

D. D. Carothers, Engineer Maintenance-of-Way Baltimore & Ohio Southwestern, Cincinnati, Chairman;

W. J. Wilgus, Chief Engineer New York Central & Hudson River Railroad, New York, Vice-Chairman;

E. H. Fitzhugh, General Manager Central Vermont, St. Albans, Vt.;

G. A. Quinlan, Vice-President and General Manager Houston & Texas Central, Houston, Texas;

James Oborne, General Superintendent Canadian Pacific, Winnipeg, Man.;

T. F. Whittelsey, General Superintendent Toledo & Ohio Central, Toledo, Ohio;

C. S. Churchill, Engineer Maintenance-of-Way Norfolk & Western, Roanoke, Va.;

J. T. MAHL, Engineer Maintenance-of-Way Southern Pacific, Houston, Texas;
F. B. HARRIMAN, Superintendent Illinois Central, Dubuque, Iowa;
Committee.

Mr. Carothers:—Mr. President, I want, before entering into the discussion, to make a few explanations. We have had no meeting of our Committee, and I find that the members present take exceptions to some things that the Chairman has proposed. The organization set forth in this report or paper emanates entirely from myself, and the other members are not in any way responsible for it. I believe they do not care to follow out the idea of it. However, so that we may provoke some discussion, I present it. It is a very hard matter for the Committee to formulate an organization that will apply to all railroads of this country, and we would be very much obliged if the members would throw some light upon this subject, so that we will be prepared to act intelligently in accordance with their views. We can't go ahead with the rules governing the organization very well until we have decided at least some of the essential features of the organization.

The President:—Well, I don't know if this report is a majority or minority report. I suppose that we will have to poll a jury in this case. Mr. Whittelsey, what have you got to say about the matter?

Mr. T. F. Whittelsey, General Superintendent Toledo & Ohio Central:—Mr. Chairman and gentlemen, I am perfectly satisfied with the report if it is merely for the purpose of discussion. The plan outlined by our chairman is not one that meets with my personal approval or that I would approve for the adoption by the Association.

The President:—Mr. Churchill, have you anything to say?

Mr. C. S. Churchill, Engineer Maintenance-of-Way Norfolk & Western:—I concur generally in what Mr. Whittelsey states. I recognize the fact that there are railroads which have organizations varying very considerably from that outlined in this report, and organizations such as we could not change. I think, therefore, that it is not quite within our province to go into the details too much. The amount of detail for us to go into had best be determined by the Association as a body, giving us instructions as to how much and how far we shall go into the business of the organization of the maintenance-of-way depart-

ment of railroads. There are thousands of miles of road represented here which have an organization entirely different from this, and I would not undertake to say which is the best, nor could I undertake to say that any one of them had bad features in them, because I think we are not in a position to decide on the good and bad features in an association meeting like this; nevertheless, there is much to be said in favor of discussion. I concur in what Mr. Whittelsey has said, that at the present time the more general lines should be taken up and others later on.

Mr. James Oborne, General Superintendent Canadian Pacific:—I drafted a letter to the chairman along the lines adopted in the presentation of the report, namely, that the character of the different roads in the various sections of the country will largely govern the organization of the maintenance-of-way department. I have not had sufficient opportunity to get through with this report and study its recommendations to be able to speak intelligently upon it, but, judging from its length, it is quite evident that the chairman has provided sufficient food for discussion.

The President:—The essence of this matter is that the chairman of the Committee considers it necessary to settle the question, or at least to determine the subject of organization, as a basis of the consideration of the question of uniform rules, and that he has suggested, not a standard organization, but a typical organization, and that about one-half of the Committee did not agree with him. The question is simply this: First, as to the proper way of carrying on the work of this Committee—whether they should make any suggestions at all in reference to organization at present, or whether they should investigate and endeavor to set forth different forms of organization, so that eventually the Association can adopt the best type of organization. The matter is now open for general discussion.

Mr. Carothers:—Before going further—if you will pardon me for a word more—my idea of this organization is that it should be a similar organization to what is known as the American Railway Association. The American Railway Association deals with subjects pertaining to transportation largely, almost exclusively. The officers and employes in that department are well understood and defined all over the country. A code of rules has been established by that association that is almost uniformly

adopted—either in whole or in part—on all the railroads, and those rules apply to individuals employed on the different railroads and their titles. It does seem to me that it is necessary to establish the positions that men occupy in the maintenance-of-way department before we can form intelligent rules governing their positions. That is the reason I have outlined this organization merely for discussion.

Mr. C. A. Wilson, Chief Engineer Cincinnati, Hamilton & Dayton:—The American Railway Association is an association of railways represented by men who can put in force whatever they wish. They have studied the questions that they pass upon. If we had in this Association, what we hope to have, and what we invited into it—all the general managers of the railways—then we could take up, I think, a good part of what Mr. Carothers has set out, but until we accomplish something of that kind it seems to me, if the Committee would devote itself to those things upon which we could pass and to which we could subscribe, the Committee would have as much as it could get through with at the start. The particular subject, it seems to me, they can do the most work on is the third subject, "Rules and Regulations for the Employes of the Maintenance-of-Way Department." The American Railway Association has not gone much further with that sort of thing than is set forth in the Standard Train Rules, which simply set forth the duties of trainmen and those employes immediately connected with them in operating or moving trains, and what should govern them. I don't believe they have even got so far as to set out the duties of other employes in the transportation department. They certainly haven't got so far as to state what the duties of the officers are, or what the titles are. It seems to me we can commence on a very small part of this subject and do a great deal of work before we try to get around to the organization of a railway.

Mr. Curtis, Engineer Maintenance-of-Way Southern Pacific:—I have had some experience in making rules for various organizations. The Southern Pacific Company's rules for the maintenance-of-way department are used on five different properties, aggregating ten thousand miles. The important part of these rules is made for roadmasters, foremen of bridges and buildings, and foremen of track and section masters. The rules are made without reference by title to other officers. They say,

"Head of Maintenance-of-Way Department." That fits anybody who acts as the head of the maintenance-of-way department. We define what is meant by roadmaster and define what is meant by superintendent or general foreman of bridges and buildings. We have managed in our rules to make them apply to three and four different kinds of organization. The important rules are directed to the foremen—the men who are actually doing the work—and it seems to me that the Committee might try working somewhat on those lines. It doesn't matter so much what you call the officer whose duty it is to supervise the work.

Mr. Wendt, Assistant Engineer Pittsburg & Lake Erie:—Mr. President, I wish to ask the chairman two questions: The report says that the Division Superintendent should practically be the local general manager of his division, and that in all maintenance-of-way matters he should report to the Chief Engineer. The Division Engineer would report to the Division Superintendent. The question arises: Does the Committee think it necessary that a Division Superintendent should be an engineer? If he is not an engineer, should he be held responsible for the maintenance of track, bridges and buildings?

What are the advantages and disadvantages of the organization in effect on the Lake Shore & Michigan Southern Railway, where all maintenance matters come directly under the Chief Engineer or his assistants?

Mr. Carothers:—Mr. Chairman, of course, the Committee did not approve this report. This is an individual report, and, as I explained in the beginning, we desire information, and we prefer that somebody who has had experience with both kinds of organizations enlighten us on this subject. That is what we are here for—to be enlightened as to what the views of this Association are. The Superintendent on many railroads is chosen from the maintenance-of-way department. In many cases he is chosen from the transportation department, and is still in charge of the maintenance, so far as the division is concerned. I don't see but that it works very well in both instances. We have both kinds on our railroad, and get along very nicely. In one instance we have an engineer, and in others have a superintendent.

Mr. H. D. Miles, Signal Engineer Michigan Central:—I think the Association can do valuable work in the matter of the organization of the maintenance-of-way department. It is, how-

ever, a question that will have to be considered at some length and a great deal of preliminary work will have to be done before any actual organization can be mapped out. The conditions on the several railroads vary to such an extent as to make it difficult to form a standard organization, and may perhaps prevent a standard form of organization. I notice that the Committee has recommended a certain form of organization for the signal department. My opinion varies from that of the Committee in regard to this organization, but as I understand that the general trend of opinion is that nothing definite will be done for some time, it is scarcely necessary for me to state my views now. I think, however, that some action should be taken by the Association in regard to rules governing the employes of the maintenance-of-way department, especially those relating to rules governing the maintenance of interlocking plants. There are a great many different kinds of rules governing the employes in charge of the maintenance of such plants, and it frequently occurs that two or more different sets of rules are placed in an interlocking tower to govern the foreman who maintains the plant. It is, therefore, advisable to have a standard set of rules for the guidance of men performing such work, and such rules could be jointly issued by all of the roads interested in any particular interlocking plant. Another point suggests itself in connection with the matter of rules for the guidance of men in charge of maintenance-of-way matters, and that is as to what committee or committees is to have charge of such work. Is this work to be performed by the special committee on Rules and Organization, or will the rules governing the maintenance of the different branches of maintenance-of-way matters come under the various committees in charge of the several special subjects?

The President:—Mr. Miles, it would seem to me that the most practical way to handle that would be, for instance, in this case, for the Committee on Interlocking to formulate the rules that are applicable to this particular work, and then to submit those rules, with reasons for them, to the chairman of the Rules Committee, so that when we get far enough along to publish general rules, they should be embodied in the report of that Committee, but it would seem that the part relating to interlocking rules, which are technical and applicable to that particular class of work, should originate with that Committee. That was the

idea that the Board of Direction had when they made this general outline of committee-work.

Mr. Miles:—That was left out—it was not mentioned in the work assigned to the Committee, and I merely wanted to know how that was to be arranged.

The President:—That was the opinion of the Board at the time the matter was discussed—that it would be handled in that way. I notice there is no particular mention made of interlocking rules under the head of Uniform Rules, Organization, Titles, etc.

This is a very broad question, gentlemen, and there is a great deal of difference of opinion in regard to the proper organization of the maintenance-of-way department, and its relation to other departments, and it is a matter, of course, that we will not be able to settle for probably a good many years to come, but for my part I cannot see why the Committee should not take that feature up in connection with their other work and give us their ideas from time to time. I think the first work of the Committee should be to find out what the present practice is; that is, how many roads use a certain form of organization, and how many roads use a certain other kind of organization, and confine their work to general organization at least, first making a statement to us what the roads are now doing, toward what form of organization they are tending, and later on, after we have discussed it thoroughly, and commenced to make recommendations as to organization — I agree with Mr. Curtis — that there is no reason why the Committee should not take up the track rules—that is, the actual working rules—regardless of the higher form of the maintenance and reorganization.

Mr. Carothers:—Mr. Chairman, the Committee being appointed at a late date, it was impossible to obtain and consider the rules of the maintenance-of-way department of roads all over the country, which is absolutely necessary before we can present anything to the Association that could be adopted. It would not be well for this Committee to introduce an entire new system, or very many new things; it should make it as composite as far as possible to be applicable to the present organization, or as nearly as possible, and develop it in the future, and with that object in view we have secured the rules of the different railroads, or a great many of them at least, but we

have had no opportunity to meet and discuss them. Therefore, it was impossible at this time to present a report regarding the rules at all. It was a very difficult subject.

The President:—We are not criticising the chairman of the Committee. Of course, we have obtained a great deal more out of these committees than we had any idea we would get out of them, owing to the short time in which they have had to prepare the subjects, and one gratifying feature of our work is that we haven't had to spur up anybody. This Committee seems to think that we should check up its chairman—this we will leave for the Committee to do.

Mr. Whittelsey:—Mr. Chairman, I think it the province of this Committee to hold a meeting to get acquainted and get to work. I then think it should classify the organization, titles and rules of the maintenance-of-way department of all the railways of the country, tabulate the information, and then we will be able to proceed to some definite object. And I would like to suggest that inasmuch as this paper by Mr. Carothers does not represent the views of the Committee, that that portion of it describing the officers and their duties be eliminated from the proceedings of the convention.

The President:—When these Proceedings are published, this discussion will be made a part of it, and it would seem to me that the opportunity that the individual members of the Committee have had to express their personal views would be enough to counteract the report, so that none of you will be misrepresented. It might be a fact that other members of the Committee may accord thoroughly with Mr. Carothers' views, and by publishing the report as he has given it, his statement that it is his individual report, and the statement from the other members of the Committee who are present giving their personal views, I think will keep that matter straight.

Mr. Wilson:—Mr. Chairman, I would like to say a word about what Mr. Whittelsey says. I noticed that our Honorable President and the other officers have been trying to get the indorsement of the higher officers of the railways in the Association, and it doesn't seem to me that we want to publish this sort of thing, that will go to some of those gentlemen, who, I know, have very decided ideas about what a railway organization ought to be, and will say: "Well, they are commencing

to do that sort of work; the boss will have to drive the wagon; we won't waste much time with it." That is what I want to say, as to trying to tell the boss how to do his work.

The President:—I don't think we ought to cut it out. I think we ought to invite the boss to get in the wagon and drive with us.

Mr. Oborne:—I would like to add this: We must not have too much regard for the boss. The boss employs men for the maintenance-of-way for their technical knowledge, and if they have anything to say as to the proper organization of the maintenance-of-way department, I think it is their duty to make that suggestion. As to whether it shall be accepted or not is a matter that remains with the boss.

The President:—The boss will have more influence over this convention by coming in here and telling us what he wants us to do and helping to pay for it.

Mr. Tratman:—I suggest, in view of this difficulty, that we add the words "as outlined by Mr. Carothers." Then it would follow as a personal paper from him, embodied in the reports.

The President:—With the qualifying statement that has been made, in the absence of the other members, I don't think we ought to make any change in the report. I think we ought to let it go as it is. Let Mr. Carothers fight it out with the Committee. This has been a very interesting matter, but we have others to follow. We will excuse this Committee and let them get together in their ideas.

We will now have the Committee on Track. This report will have to be read. Mr. Handy turned the matter over to Mr. Baldwin, the vice-chairman, and Mr. Baldwin could not give it attention. We have Mr. Moll, Mr. Robinson, and Mr. Landon, members of the Committee, and Mr. Landon will read the subject-matter which he has in his possession. We will, therefore, have to excuse the Committee from an elaborate report.

Mr. H. C. Landon, Chief Engineer Buffalo & Susquehanna:—Mr. Chairman, I fully expected Mr. Baldwin to be here yesterday, and the rest of the Committee evidently did

so as well, and I expected to be here myself, but missed connections on account of the weather in our country. This morning I received a communication from Mr. Baldwin stating that he would not be here, and he left me certain papers, which contained a scheme of report from Mr. Moll, and we will read that as our report, as we are unable to do anything further, and it covers the ground.

REPORT OF COMMITTEE V.—ON TRACK.

To the American Railway Engineering and Maintenance-of-Way Association:

1. Maintenance of line:

The rails on tangents should be brought to true, straight line, special care being taken to remove short kinks; and on curves they should be truly lined to centers, the ends of the curves being eased by spirals to extend each way from the original point of curve as far as may be permitted by the width of the roadbed.

The center line of long tangents and of curves should be established by careful instrument work, and all work on track should be done in reference to such line.

To secure permanency of center line, either monuments or reference points should be established at the points of curves, and at intermediate points on long tangents.

2. Maintenance of surface:

The elevation of curves should be governed primarily by the speed of trains passing over them; but as the speed varies greatly with the same train at different places, and still more with different classes of trains, it necessarily follows that no rule can be laid down for the elevation of any degree of curve at all localities, but each case must be judged by itself, and subject to such considerations as the judgment of the Roadmaster may dictate.

As the comfort of the traveling public is rather to be sought for in this matter than other considerations, the subject of passenger trains is generally taken to govern the amount of elevation to be given to curves. This amount is given in well-known standard tables of elevation of outer rail of curves.

When curves are spiraled, the elevation should, theoretically, begin at the beginning of the spiral, and reach its maximum where the spiral ends and the true curve begins; but this is generally too short a distance, and makes the rise too abrupt. The following rule we find a good one:

The elevation to be at the rate of one inch per fifty feet on the tangent approaching the curve, and to reach the full amount of elevation at the beginning of curve.

Some claim that curves ride better by using two-thirds of the elevation on the tangent, and running out the remaining one-third to full elevation on the curve. When there is not more than one hundred feet of tangent between two curves in the same direction, the elevation should be carried without reduction from one curve to the other, but if the distance is more than one hundred feet, the elevation of each curve should be eased off to whatever it may be at a point midway between them.

All abrupt changes of grade should be eased by vertical curves. This is especially important at the foot of steep grades and when a level grade changes abruptly to a descending grade.

3. Maintenance of gauge:

In gauging track, the gauge should be placed squarely across the track; the rail held tight to the gauge; the outside spike started first; both spikes driven at the same time, and the gauge not removed until both spikes are driven home.

The inside spikes of both rails should be to the same side of the center line of the tie, and the outside spikes to the opposite side. This helps to prevent the slewing of the ties.

All curves of six degrees and under should be of true standard gauge. The gauge of curves of over six degrees may be widened at the rate of one-eighth inch per degree up to three-fourths of an inch, or to a gauge of 4 feet 9¼ inches, which should be the limit.

The spreading of track and canting of rails is best prevented by the use of tie-plates.

4. Inspection of track:

Where track is liable to be obstructed at certain seasons by washouts, landslides, falling rocks, etc., track-walkers should be stationed to patrol the track and give warning to trains. Whenever, for any reason, the regular track crew cannot run over the section, one of their number must be detailed to patrol the whole section, in one direction at least. It must be the first duty of sectionmen, in starting out for the day's work, to examine carefully all switches, frogs, crossings, derailing points, interlocking plants, etc., and see that the same are in sound condition and in good working order.

5. Tools:

Following is a list of tools furnished to the respective sections into which the track force of the Chicago, Milwaukee & St. Paul Railway Company is divided, with instructions governing the accounting for the same:

STANDARD LIST OF TOOLS AND MATERIAL

To be carried on each Section.

Class A.	Class B.	Class C.	
1	1	1	Adze, Handled.
1	1	1	Ax, Chopping, Handled.
1	1	1	Ax, Hand, Handled—2 where needed for shimmi
8	8	6	Angle Bars.
100 lb.	100 lb.	50 lb.	Bolts, Track.
1	1	1	Brace and Bit, ⅝-inch, where needed.

Class A.	Class B.	Class C.	
1	1	1	Brooms.
3	2	2	Bars, Claw.
5	4	3	Bars, Lining.
6	4	4	Bars, Tamping.
1	.....	.....	Bars, Raising.
1	1	1	Cars, Hand.
1	1	1	Cars, Push.
6	6	4	Chisels, Track.
6	4	3	Cutters, Weed, where needed.
2	2	2	Cans, Oil, 1 gallon.
2	2	2	Dump Boxes for Push Car.
1	1	1	File, Flat, 12-inch.
1	1	1	File, Three cornered, 6-inch.
.....	.....	.....	Forks, Manure, where needed.
2	2	2	Flags, Red.
2	2	2	Flags, Green.
1	1	1	Grindstone and fixtures.
1	1	1	Gauge, Track.
1	1	1	Grass Line, 200 feet.
1	1	1	Hammers, Nail.
3	2	2	Hammers Spike, Handled.
2	2	1	Handles, Spike Hammer, extra.
2	2	1	Handles, Pick, extra.
1	1	1	Handles, Adze, extra.
1	1	1	Hand Rake (iron), where needed.
1	1	1	Hand Car Oiler.
2	2	2	Lanterns, White.
2	2	2	Lanterns, Red.
2	2	2	Lanterns, Green.
5 lb.	5 lb.	5 lb.	Nails.
100	100	100	Nutlocks and Washers.
4	3	2	Picks, Dirt, Handled.
6	.....	.....	Picks, Tamping, for stone ballast.
1	1	1	Rail Punch.
8	6	4	Shovels, Track, one for each laborer and foreman, and 2 extra, Class A—1 Extra Class B and C.
4	2	2	Shovels, Scoop, where coal or cinders are handled in summer, and for all sections for snow in winter.
1	1	1	Saws, Cross-cut.
1	1	1	Saws, Hand.
1	1	1	Spike Puller.
1	1	1	Sledge, Handled, 18 lbs.
5 lb.	5 lb.	5 lb.	Staples.
6	4	3	Scythes, Grass, weed or brush, one for each man where needed.
1	1	1	Tape Line, 50 ft.
1	1	1	Track Level.
200 lb.	200 lb.	200 lb.	Track Spike.
1 box.	1 box.	1 box.	Tie Plugs.
12	12	12	Torpedoes.
1	1	1	Track Jack.
4	3	2	Wrenches, Track.
1	1	1	Wrenches, Monkey, 14 inches.
1	1	1	Wire Stretchers.
6	4	3	Whetstone (one for each scythe).
1	1	1	Water Pail and Dipper or water keg, Wheelbarrows, where needed.

TO BE CARRIED BY ROADMASTERS AND SENT BY THEM WHERE NEEDED:

3 Rail Drills.
18 Drill Bits.
2 ¾-inch Augers.
4 Track Levels.

The sections of this company (C., M. & St. P.) are to be divided into three classes (A. B and C.), for the purpose of indicating what tools are to be carried on the sections of each class. The above is a list of tools and material which each section will be permitted to carry. The classes of each division will be indicated by special notice. Section foremen must keep a strict account of all tools received, and at the end of the month, report upon the blank under proper heading, tools and material on hand the first of the month, received during the month, and on hand the last of the month, and forward the report promptly to the roadmaster on the first day of each month. Roadmasters must check and approve the report and then forward it to division superintendent.

Section foremen will not be allowed to carry more tools or material than is shown on the list.

Each month, or oftener if necessary, or less frequently if desirable, roadmasters will arrange to start a car over their divisions to pick up surplus and broken tools for shipment to the storekeeper. In making such shipments, foremen must securely tie up the tools and attach a tag which must show a list of the tools sent, and from what section and division, and by what foreman. They must fill out blank and hand to the agent at the station from which the tools are shipped, and obtain from the agent a receipt for tools so forwarded, which must be carefully preserved.

When necessary to send tools for repairs, foremen must securely attach a tag to the tools on which must be shown a list of the tools sent and from what section, division, and by what foreman. Foremen must obtain from the agent receipt for tools so forwarded.

Section foremen will be required to account for each and every tool sent them, and a broken or worn out tool will be required for each new one furnished. The new tool will be sent before the old one is returned to the storekeeper if necessary, but the account will be held against the foreman until the old tool is received by the storekeeper.

When extra or floating gangs are to be organized, requisitions for tools will be made by the roadmaster of the division where the gang is to work, who will be held responsible for the care and final return of the tools to the storekeeper.

In such cases the roadmaster will carry out the instructions prescribed for section foremen.

The handcars and pushcars which have been in general use on that road, until recently, have been of their own make, with no special features, but with large heavy cast wheels. These are excellent cars of their kind, and cannot be surpassed for large gangs of men, but are too heavy to be readily handled by small section crews, and they are gradually replacing them with light cars of standard modern make.

6. Frogs and switches:

For turn-outs from the main line, split switches and spring rail frogs should be used. For yards, rigid frogs and stub switches have generally given good satisfaction; but with the increasing weight of engines, the strains on the switchstands are becoming so great that split switches are coming more into favor in yards and on sidings.

A No. 10 frog gives an easy lead from the main line, where traffic sometimes passes at considerable speed, and this is a suitable, if not the best, angle to use.

For increasing the safety of facing point switches, cam locks should be used, which insure the point being in perfect contact with the stock rail.

7. Crossings:

The track at crossings should be prepared with special care, on account of the unavoidable pounding of trains passing over them, and drainage should be as perfect as possible.

These conditions are probably best filled by using as ballast a heavy body of crushed stone. Plate-riveted and filled crossings are the ordinary types in use. Our experience has been most satisfactory with reenforced filled and bolted crossings.

8. Guard-rails:

Guard-rails should be of the same height as the adjoining track; should be about ten feet long for rigid frogs and fifteen feet long for spring frogs. The last foot at each end should be bent outward at an abrupt angle, to give more stability, and as a means of securely fastening it to the ties. If not bolted or clamped to the track rail, the guard-rail should be braced with not less than four rail braces.

The flangeway at a point opposite the frog points should be 1¾ inches wide, tapering gradually to three inches at the end. At the ends of guard-rails, as well as at all places about frogs and switches, where there is liability of the foot being caught, foot-guard protection should be provided. This may be done by special castiron fillings, by plank fitted into the spaces and secured by spiking to the tie or by Hart foot-guard, bolted to guard and track rail.

9. Joints and fastenings:

Notwithstanding the large number of joint fastenings of varied designs in regular use and on trial, none, so far as we are aware, have shown any great superiority over the standard angle bar; and we look for the ideal joint fastening to be a modification of the angle-bar, with a rail-base support, and in as few parts as possible, preferably only two.

10. General questions:

Policing:

As far as is consistent with the demands of trackwork proper, a certain amount of time should be devoted to the work of putting the right-of-way and station grounds in neat and orderly appearance.

Tall trees which would reach the track in their fall should be cut down and removed, if upon the right-of-way; if outside the right-of-way, they should be removed, if possible, by agreement with the owner of the land, and such agreement should be made a matter of record.

Brush and weeds must be cut and burned; grass mowed or burned; and old ties as soon as removed from track must be piled. New ties which have not been used must be neatly piled where they may be easily reached if necessary.

Track scrap, as well as links, pins, or whatever may fall from passing trains, must be picked up daily, carried to the station, and placed on a platform provided for that purpose.

Rubbish or litter of any kind must be removed from the station grounds, and lawns about them must be kept neatly trimmed and watered.

Highways and farm crossings must be kept in good repair.

Fences must be kept in good repair; ends of posts and boards sawed

off to true lines; and all broken boards, slivers and blocks which cannot be utilized must be burned.

Portable snow fences when removed from the fields in the spring must be neatly piled, and grass and weeds removed from around them, so that they may not be in danger of fire.

E. A. HANDY, Chief Engineer Lake Shore & Michigan Southern Railway, Cleveland, Ohio, Chairman;
H. F. BALDWIN, Chief Engineer Chicago & Alton, Chicago, Vice-Chairman;
S. B. FISHER, Chief Engineer Missouri, Kansas & Texas Railway, St. Louis, Mo.;
W. W. GWATHMEY, JR., Chief Engineer Seaboard Air Line, Norfolk, Va.;
A. S. CHEEVER, Chief Engineer Fitchburg Railroad, Boston, Mass.;
W. B. POLAND, Division Engineer Baltimore & Ohio Southwestern Railroad, Washington, Ind.;
G. S. CHEYNEY, Assistant Division Engineer New York Central & Hudson River Railroad, Buffalo, N. Y.;
J. B. MOLL, General Roadmaster Chicago, Milwaukee & St. Paul Railway, Chicago;
J. B. ROBINSON, Resident Engineer Southern Pacific Co., Sacramento, Cal.;
H. C. LANDON, Chief Engineer Buffalo & Susquehanna, Austin, Pa.;

Committee.

The President:—Have you anything to say in reference to the report of this Committee? I think we ought to be congratulated, in fact, that although the chairman and vice-chairman are not able to attend to this matter, we still have a report.

Mr. Thomas Appleton, Chief Engineer Copper Range Railroad:—There is one subject which I think the Track Committee might well consider, and that is the advisability of using heavier rails and a less number of ties. Some two years ago, when rails were much lower in price than they are now, I thought that I could demonstrate, to my own satisfaction at least, that it would be economical for roads having a heavy business to increase the weight of rail and decrease the number of ties in the track. Track labor goes largely into the renewal and tamping of ties, and if the number of ties was reduced, the amount of this class of work would be reduced also. The cost of ties had been increasing and the price of rails diminishing, so that the proposition was an attractive one. I found it difficult to get statistics upon which to base the necessary calculations, and the conditions varied so much in different parts of the country that a universal rule was out of the question.

There is no difficulty in getting a rail strong enough to carry the loads imposed upon it, if the supports are all right. A seventy-five-pound rail does not require bearings every two feet if the bearings give substantial support. A great deal depends upon the character of the ballast used. At present the rise in the price of rails gives the question a different aspect. I believe that it would be economical to use larger ties and a less number of them, even if we maintain the same aggregate amount of bearing surface, as the number of ties to be tamped and renewed and of spikes to be driven would be less.

My investigations showed that in a given case, where the cost of ties was known and the cost of renewing them could be closely estimated, that I could prove my proposition in either way by varying the rate of interest charged on cost of material and labor.

While it may not be a matter for the Track Committee exclusively, it would be a good thing for the Association to consider what decides the rate of interest to be charged on first cost of projected improvements. For instance, we make an estimate of cost of remodeling a switching yard, and find that if the yard is rebuilt the same work can be done with one less switching crew, and a saving of so many dollars per year can be shown. But what of the interest on the investment—that silent, never idle factor that is working 365 days every year? Some rate of interest must be assumed in order to estimate the value of the projected improvement. A high rate of interest might kill the project and a low rate carry it through with a handsome margin.

The President:—I would like to say to the Committee on that subject that our road went into the question, and we came to the conclusion that we wanted to use a heavier rail and more ties, and found that was economy. The most economical track you can have is the most stable track. The value of the increase in the weight of rails is not to prolong its life or its wearing qualities. You get the maximum amount of wear out of a rail in the thirty-second of an inch of the outside. To secure a stable track it is necessary to have a stiff rail, and you must consider it in the form of a series of bridges or girders supported by piers. The heavier you can make the girder and the closer together you can put the support, the more stability

you get in the girder. What tears our track to pieces is not entirely the vertical weight that goes on it, but it is the flexure of the track, perhaps due to the flexure of the rail over the ties. This causes the ties to become loose, or may be due to the flexibility of the soil, or the disturbance of the ballast and the soil together, due to the impact and the weight of the train running over it. What we should strive to arrive at is stability, and the stiffer you can make the track, the heavier your rail, and the nearer your supports are under the rail, and the more ballast you have, the more economical it will be to keep up the track and maintain a strong track.

Mr. Cushing, Engineer Maintenance-of-Way Pennsylvania Lines West:—Mr. President, I heartily re-echo your remarks. We have been away behind the transportation department in keeping up with the increased weight of motive power. Our track has always been attacked when any question of increased motive power has been suggested, simply because we have been lagging behind. We have never led the procession. We have always followed in the rear, but it is time now to lead the procession.

The question of ties is going in the wrong direction, as it is not fewer ties per rail which are desirable. That was the first idea that seemed to prevail when the heavier rail was purchased, but a short experience with the fewer number of ties soon convinced me that it was a mistake. What we gained in the increased rail we lost at once by decreasing the support under the rail. At best, the supports by which we transmit loads to the roadbed are too small, and possibly we can never get them large enough. I think the ties should be as close together as will permit us to properly surface the track when required. That means at least as many ties as we use at the present time, and they should be as close together as will allow a shovel to be placed between them. A scientific investigation of the load-carrying power of the subgrade, for weights transmitted through the ties and the ballast, will show that the heavy weights of locomotives in use at the present time, and which may be increased at any time, will make it necessary to have all the bearing power we can get from the ties.

In taking up this question of track, one of the most important questions to start with is the relation between wheel

gauge and track gauge. It is a question which has never been dealt with in conjunction by motive power and maintenance-of-way departments. It is really a serious matter, as shown by the severe wrenching of our frog guard rails and other guard rails, due to the variety of gauge of motive power and car wheels in use to-day. There are limits of the Master Car Builders in the matter of wheel gauge which will allow both wheels to scrape as they pass through the flangeway. That is a very bad condition of affairs, and yet is a fact, and I think it is about time that the engineers proclaim their views on the subject.

The President:—There is one small matter here that I have made a note of. The members of the Association may have met the same problem and may have solved it in the same way. On the Illinois Central Railroad we have had a great deal of difficulty, as all railroads have, in the maintenance of the joints at the highway crossings. These crossings, of course, are planked, and a section boss never likes to rip up these planks or disturb them. He does not notice the low joint there, as they are not so noticeable as at other points. At one time we considered the question of getting enough sixty-foot rails to intersperse with the other rails, so we would have the joints come inside the limits of the crossing. The other day I went over our Springfield Division. The men were laying new rails, and I found the Roadmaster solved the problem in this way: When they approached a highway crossing they measured the distance to it and used a few of their short rails, and so arranged that they would not have a joint come inside the limits of the planking.

Mr. H. G. Kelley, Chief Engineer Minneapolis & St. Louis:—In connection with this discussion upon track and its maintenance, I would like to call the attention of the Committee to the effect upon track maintenance due to the details in design of motive power. It has been my misfortune to run against one item of this kind three times.

Opposite Cairo, some three years ago, a very heavy switch engine was sent into the yard. The switches were all stubs, and almost immediately after this switch engine commenced operating the gauge was spread on every switch to such an extent as to bend the switch rails and cause constant derailments. The motive power department naturally blamed it upon

the track, and, upon the other hand, the track department claimed that the trouble was due to some defect of the engine. It was solved at last by noticing that the buffer castings between the engine and the tank were both plane surfaces. Whenever the engine backed up with a string of cars, these two perfectly flat planes coming together with a heavy train behind them permitted no play between the engine and tank. The result was the engine backing up would tear out any switch ever put in.

The casting upon the tank was then made with a convex radial surface, and the trouble ceased at once. It occurred again at another terminal yard on the Mississippi River, where the same difficulty was found to exist, and was remedied by the same method.

On the road with which I am now associated we put some heavy Mogul engines into service this last fall. Immediately all the stub switches on the road went to pieces as fast as these engines backed over them, and after three months of trouble the convex castings are being put on the tanks. These engines came from one of the largest locomotive works in the country, and it is singular to me that the matter had not been brought to the designer's attention before. It does not seem probable that I should be the only one to have trouble of this kind, but I believe it to be suggestive of some of the difficulties which maintenance-of-way departments meet, and which are due to the details of design of motive power and rolling-stock.

Mr. A. W. Sullivan, General Superintendent Illinois Central:—Mr. Chairman, I would like to suggest to this Committee the necessity for establishing a capacity for tracks. We have capacity for locomotives, for cars and for bridges; we want a capacity for tracks. In other words, given a certain specification of track, what is that track capable of safely carrying, both as to weights of load and as to speed? I don't know of any way in which the use of track could be better regulated than by establishing a standard of service which the track can normally bear; and while I don't know that it has ever been done, it doesn't seem to me to be an impossible thing to do, because of the fact that the specifications of the track and the specifications of the rolling-stock that make use of it can be so ad-

justed mechanically that the defects which have been mentioned by the last speaker will not be normal to its use, but the things that are normal to its use should be regulated or gauged by some system that will admit of developing the highest use of the track. At the present time there is no means of knowing what advantage accrues from the substitution of a heavy rail for a light rail, of stone ballast for other forms of ballast, or from any of the material improvements which are being made from year to year in tracks, except as expressed in the duration of the track. To my mind that is not the only consideration. The duration of the track happens to be the element in which I am least concerned personally, but I am concerned in knowing what the limit of safety is in the use of the track. My position is that of using the track to its fullest extent; in other words, to get just as close to the limit in the normal use of the track as it is capable of bearing without injury, leaving the question of its economical use to be adjusted as between the tonnage that is moved over it and the length of service which it will endure. It has occurred to me that some measure of capacity might be developed. For instance, we will assume that a sixty-pound rail is capable of safely carrying trains (and it shouldn't make any difference whether they are freight or passenger) at a speed of sixty miles an hour. Is it a safe proposition to assume that a seventy-pound rail is good for seventy miles an hour, an eighty-pound rail for eighty, and a hundred-pound rail for one hundred miles an hour? The idea underlying that thought is that the increase in the weight of the rail should carry with it capacity for a superior use. It is not sufficient, in my mind at least, to change from a sixty to an eighty pound rail merely to have the rail last fifteen years instead of ten years. There must be with that change the opportunity for a higher use, and that higher use means the capacity to carry much heavier weights and to move at much higher rates of speed. The determination of the capacity of track, the capacity of its use rather, would be of great value in many ways other than that of the transportation service alone, because it would have an effect upon the rolling-stock. It would determine the limitations, both of the locomotives and cars, in their relation to the track. I do not think it is quite a fair proposition to expect a track to carry all weights of cars at any rate of speed

and to consider that use normal. There should be certain relations established between the physical construction of the track and the uses to which it may be put. We should know what those limits are within which such use can be considered normal. I hope this Committee will consider that question within the range of the subjects that come under the general heading of "Track."

Mr. D. W. Lum, Assistant General Superintendent Maintenance Southern Railway:—The track department has, and always will have, a very difficult matter in answering that question. An engine, or a bridge, with which we are perhaps more familiar, may be calculated and proportioned with exactness. The members may be adjusted with exact reference to each other, so that the bridge will be strong. An engine may be so constructed and proportioned and the various members so calculated that it will be of uniform strength, and it then may be classed as able to perform so much service. Unfortunately, we have to depend on the earth for our foundation. The parts of the engine, you manufacture; the earth, you take as you find it. The earth may be of a certain kind; a certain section may be of certain strength, and we may know is capable of supporting such a load, and we may be able to class the rail with the engine—an engine of so much capacity, a rail of so much capacity. The ties may have a certain strength, and we may so class them. A certain amount of ballast may act as a cushion to transfer the load from the rail and tie to the earth. It is probably the experience of all of you that track that will stand up, as the trackmen say, at one point, will utterly fail at another. You may pass through a rock cut here, and after putting a certain amount of ballast under the tie, you can then say to the motive power department: "That track is good for such a load or for such a service." Passing from the rock cut, you may encounter a marsh that may have been giving you trouble for many years, and may be now unreliable. There may be other places where you depend on the soft roadbeds that will perhaps take ten years to settle, that you cannot absolutely measure as to their capacity, and I doubt if we will ever be able to say of a continuous line of road, "This is the exact limit of that roadbed." We may say, "This is the limit of the rail, of the tie, of a foot of ballast;" but we do not know what

the limit of the natural material which we are availing ourselves of can be. Therefore, I do not think we will ever be able to specify so near the line as we may work in bridge construction or in motive power construction. (Applause.)

Mr. F. H. McGuigan, General Superintendent Grand Trunk Railway:—Inasmuch as all the suggestions which have been offered up to the present time have come from representatives of the greater railway systems (a majority of which usually provide ample funds and necessary facilities for properly maintaining their tracks), we must warn you not to lose sight of the fact that these great systems represent less than half the railway mileage of this continent. The smaller lines, representing a large majority of the mileage, being restricted in their expenditures by their limited earnings, cannot aspire to the perfect conditions which many gentlemen have described; therefore, I should like to suggest that if the Committee can point out a way in which these lighter and less fortunate lines can maintain their tracks safely and more economically than at present, they will confer upon such roads an immense benefit.

The President:—Have the Committee anything further to offer? They have received a great deal of good advice. We would like to get back at them in some other way.

We will now call on the Committee on Bridges and Trestles. Gentlemen, I take pleasure in introducing Mr. McGonagle, the vice-chairman of the Committee, who will read the report.

Mr. W. A. McGonagle, Resident Engineer and Superintendent Bridges and Buildings, Duluth & Iron Range Railroad:—Mr. President and gentlemen, I regret very much the inability of Mr. Bates, the chairman of this Committee, to be present. The Committee fully expected his presence, and relied upon him for the formal report. He is seriously ill with la grippe, and will not be able to be present at all at any of our meetings. The Committee, at a meeting to-day, very kindly allowed me to write a report, stipulating that I should not say anything for which the convention should jump upon them, so if there is any jumping to do, you will please do it on me.

REPORT OF COMMITTEE VII.—ON BRIDGES AND TRESTLES.

To the American Railway Engineering and Maintenance-of-Way Association:

The Committee on Subject 7—Bridges and Trestles—can only, at this time, submit a brief outline upon which to elaborate a formal report at our next annual meeting.

The subject is a broad one and so vital in its relations to the safety of the traveling public, as well as to the vast property interests involved, that it demands earnest and careful study and expert knowledge to develop the best plans for future guidance.

We are in an age of expansion, and nowhere is this fact more in evidence than in the rapidly increasing unit loads passing over our bridges and trestles of the present period. Bridges that were considered to be far in excess of the requirements of ten years ago are to-day considered with suspicion by those maintenance-of-way engineers who are responsible for their safety, and the question, "What shall we do with our old bridges?" is one of the most serious that confronts the managers of our railways to-day.

Your Committee believe that the best interests of the Association will be served by limiting the sphere of the first formal report at our next annual meeting to the subject of bridges and trestles in iron, steel and wood, believing that the time allotted to the Committee will be fully occupied by a careful consideration and discussion of this branch of our subject, and for this purpose we hope that each member of our Association, who is by experience qualified to give accurate data on this subject, will come forth without further solicitation and give to our members, through the Committee, the benefit of his experience. The very fact of this convention is evidence that the barriers, largely imaginary, heretofore existing between the railroads, are broken down, and that each can learn something from the other. We thus welcome a new era in the dissemination of practical knowledge among the different railroads of our country.

In regard to the subject of iron bridges and trestles, we recommend that each railroad submit to the Committee typical plans and specifications of its most modern structures, giving maximum span employed in

1. I-beam spans;
2. Plate-girder spans;
3. Lattice spans;
4. Pin-connected spans.

Also,

1. Methods of calculation;
2. Units employed;
3. Methods of inspection;
4. Methods of erection;
5. Methods of maintenance.

Your Committee hope from this time to recommend typical specifications and uniform practice as to length of spans, except in such cases where local conditions prevent the use of any standard plan.

In regard to the subject of wooden bridges, we recommend the same general procedure, giving the various modern types of wooden bridges used, the length of span employed, the kind of materials entering into the construction and the methods used for protection from the elements.

In regard to pile and trestle bridges, it is the intention of your Committee to prepare a tabulation of all the modern types of such bridges, giving in detail the different sizes and kinds of piles and bridge timbers used, size and shape of drift bolts used in various parts of the structure, methods of numbering, and methods of inspection and renewing. In order to prepare this tabulation we need, and respectfully invite, your co-operation.

Your Committee believe that a fund should be established and the different railroads invited and urged to contribute to the same, for the purpose of making careful experiments along the lines of the subjects which we have under consideration.

Your Committee invite the suggestions of members as to which part of the subject they particularly desire to be discussed, and we will endeavor to exert our energies along the lines indicated by them. Your Committee fully realize that this subject cannot be exhausted in any one year, or three years, but we hope, if aided by those having experience, to present from time to time themes for discussion which will draw out from those possessing special knowledge, and also from those possessing general knowledge, ideas for simplifying and systematizing the practice of our different railroad engineers.

ONWARD BATES, Engineer and Superintendent Bridges and Buildings Chicago, Milwaukee & St. Paul Railway, Chicago, Chairman;
W. A. MCGONAGLE, Resident Engineer and Superintendent Bridges and Buildings Duluth & Iron Range Railroad, Duluth, Minn., Vice-Chairman;
A. ZIESING, Consulting Engineer, Chicago;
I. O. WALKER, Division Engineer Nashville, Chattanooga & St. Louis, Paducah, Ky.;
E. BARRINGTON, Principal Assistant Engineer Vera Cruz & Pacific, Mexico, Mex.;
R. MODJESKI, Consulting Engineer, Chicago;
D. W. LUM, Assistant General Superintendent Maintenance Southern Railway, Washington, D. C.;
B. DOUGLAS, Bridge Engineer Michigan Central Railroad, Detroit, Mich.;
WILLIAM MICHEL, Engineer Maintenance-of-Way Hocking Valley Railroad, Columbus, Ohio;
T. L. CONDRON, Civil Engineer, Chicago;

Committee.

The President:—There was one thing that was talked over by the Board of Direction last night, which I will state to the Association, and particularly to the chairmen of the committees, that in order to save work for the chairmen of the committees,

whenever they want information from other roads they should address the Secretary, at the Monadnock Block, Chicago, the headquarters of the Association, and ask the Secretary to get certain information for them. He will correspond with different railroads and collect the information and turn it over to the chairman of the committee, and thus save the chairman of the committee a great deal of unnecessary correspondence with different roads, and it is expected and hoped that all railroads will have an understanding with their managing officers and engineering departments, so that any information that is called for from them by the Secretary of the Association will be promptly furnished.

Mr. Carothers:—Does that include compiling of information under the direction of the chairman?

The President:—The idea was that the Secretary should do that as far as possible, and a little later on that the chairman of any committee who found he had more work than he could promptly attend to would communicate with the Board of Direction and either ask that he have an assistant sent him in the form of an assistant secretary to work for him, or secure a limited appropriation from the Association to employ someone to help him do this work. That is, when the work becomes so large that we don't feel like sponging on the railroad companies, let our committee chairmen apply to the Secretary for assistance.

I think Mr. Peterson has some ideas on this question. I have talked with him from time to time, and I think he is competent to open the matter, particularly what shall be done with our old structures and to what extent we can safely overstrain them. The subject is open for discussion.

Mr. Peterson:—I do not care to give any opinion.

The President:—I will save Mr. Peterson that embarrassment. It is a fact we all have to face every day—every bridge engineer, every chief engineer and every managing officer in the United States. I presume there is not a railroad structure—possibly with the exception of some built within the last few years—but what at times is what the bridge engineers would technically call overstrained. It is quite a serious question with the managing officers of the railroads and the bridge engineers as to what extent it is advisable or safe to use those structures.

Mr. C. S. Churchill, Engineer Maintenance-of-Way Norfolk & Western:—Mr. Chairman, it seems to me that raises one point it might be well for the Committee to get information upon. We are asked every day when we expect to replace a bridge or temporarily trestle it. I think every railroad represented here has some method or some limit to which they work, and I think it time for the Committee to get a statement of what that limit is—at what strain per square inch in tension shall a bridge be trestled or removed.

The President:—To illustrate that question, generally the bridge engineer says: "I will figure the unit strain of the members of this structure at eight thousand pounds per square inch, and the elastic limit of this metal according to our specifications is thirty thousand, and the maximum strength fifty or sixty thousand pounds, and the motive power increases until finally the members of that bridge are subject to a strain of sixteen thousand pounds; and the managing officer calls him in and asks, "How much is this bridge overstrained?" And the bridge engineer says: "One hundred per cent." That would strike the passenger who rides on our trains as something eminently unsafe, whereas the fact is that the strain has not been over the elastic limit of the metal; it has not reached the point to which, theoretically, that metal can be safely strained. Then one engineer may make that statement on the basis of dead load, and another may make it on the basis of consideration of impact, and it is a question of a great deal of importance. Now, there is some limit, it seems to me, as to when we should strengthen a bridge or take it down and replace it. We would be following a rule which has been laid down and established as a safe one, if it were understood among engineers and managers that we couldn't go beyond the limit, and we would not assume the responsibilities, as a great many of us do, when we have to permit the use of a structure strained beyond the original theoretical limit. Of course there is this thing to consider about every structure, and that is the relative importance of the different members and the way they are strained and the details of construction—the location of your bridge, whether it is at the foot of a heavy grade, or at the end of a yard in your station, where your trains run over at full speed, and all that sort of thing—but it is one of the very annoying questions that railroad

managers and chief engineers and bridge engineers have to meet every day in the year. I do not think our Committee can do us a greater service than to investigate the subject along these lines.

Mr. M. H. Rogers, Chief Engineer Denver & Rio Grande Railroad:—I am very much obliged to you for the remarks and suggestions that you make. I am very glad to know that some of our roads, with an unlimited amount of capital, do overstrain their bridges. The Denver & Rio Grande road was started as a narrow-gauge system. When I was first associated with the road, some twenty years ago, we were using a thirty-pound rail, and everything in proportion. Now we use a very heavy rail with loads in proportion. In former years we built some iron and steel bridges for the then narrow-gauge lines, that are now deficient for standard-gauge requirements. Some three or four years ago the President and General Manager took up the matter with me carefully, and just before I left Denver for Chicago I received notification of an order for some new freight engines, which load to the maximum our bridges—our strong, heavy bridges, that were going to be heavy enough for anything we would have for years to come. We must meet the problem and take out the remaining narrow-gauge bridges on our standard-gauge lines and remove them to the narrow-gauge lines or strengthen them for heavy standard-gauge service.

If the Committee do take up the question of strengthening bridges or renewing them, it will, I assure you, be a subject that will deeply interest us in the immediate future.

When we changed our main line from narrow to standard-gauge through the "Royal Gorge," reducing our curvature to ten and twelve-degree curves, doing as heavy work as was required by the original construction, we introduced spiral easements, adopting Searles' system. We found occasionally that we could scarcely get in the complete spiral if we used a ten-foot chord, the intervening tangent being too short. In these cases, to lengthen the tangent would have been such heavy work that it would have been practically impossible. Last summer we built twenty-seven miles of broad-gauge line. We had quite a number of high wooden trestles, averaging from thirty feet to ninety feet on the center line, with a side slope of from one in two to one in three. We used a twenty-foot, instead of

the usual sixteen-foot, space between bents. For stringers we used Oregon, or "Douglass," fir, forty feet long, twenty-four inches deep and eight inches wide—six stringers. The stringers were sprung to fit the curve and laid so as to form practically a continuous chord, and have so far proven entirely satisfactory.

The President:—Gentlemen, I believe we have given this Committee a good idea of what we would like to have them do between now and the time of the next meeting.

The Committee on Records, Accounts and Reports will please come forward.

Mr. H. F. White, Chief Engineer Burlington, Cedar Rapids & Northern, chairman of the Committee:—This Committee has had no meeting heretofore. It might be a different matter if the whole Committee had to do with the preparation of the report.

REPORT OF COMMITTEE XI.—ON RECORDS, ACCOUNTS AND REPORTS.

To the American Railway Engineering and Maintenance-of-Way Association:

The work of the Committee of which I have the honor to be the chairman differs from that of the other committees of the Association in that it deals with the records and cost of work done, while they have to do with the manner of accomplishing the work.

It is very important that accounts and records of all transactions should be accurate, clear and arranged in a manner that admits of easy reference, for the records of the past furnish us the only reliable means of estimating the future. Why is it that the estimate of nearly every piece of work falls short of the actual cost, if not because the cost of similar work in the past has not been accurately kept and properly classified?

The work of this Committee should begin with the notes of the location survey, recommending the manner in which to keep these; then, taking up the right-of-way deeds, with their numberless conditions and side agreements, all of which should be arranged for easy reference, and the original carefully preserved.

This Committee should recommend as to the scales of maps and profiles that form parts of the records of all railway companies, and what should be shown on them, and emphasize the importance of keeping them up to date.

On looking at the headings into which the subject-matter of this Committee's work has been divided by the Board of Direction, it would seem that, to be logical, the numbering of the last two heads should be transposed, number three being changed to number two. The accounts

are made up from the reports, and naturally come after them in point of time. Anyone who has had any experience in a maintenance-of-way office knows how hard it is to get an intelligent report from a section foreman, or even from those from whom better things are expected, even when printed blanks are used. They are apt to get the right item on the wrong line, or write it across several lines. The one thing that seems to claim their greatest effort is to give the total days worked correctly.

Material reports are generally less accurate than time reports. Now, unless the reports are accurate, what hope has the bookkeeper that he can present any figures that are worth anything? In view of these conditions, the Committee should recommend just as few and as simple reports of time and material used as will state how much was received, how much used, and what use was made of it; and, in the case of material, show what was on hand at the end of the month.

The form of miscellaneous reports, including accidents, fire claims, stock killed, and others of a casual nature, should be plain and concise, confined to facts rather than opinions.

The recommendations of the Committee as to accounts should contemplate only the accounts kept for the use of the maintenance-of-way department.

The Association of Railway Accountants, in connection with the Interstate Commerce Commission, has recommended a general form of accounts to be kept by the auditing departments of the railways, and this has, in some instances at least, been adopted by the railways.

Every officer in charge of maintenance-of-way reports to the accounting officer the expenses of his department for each month, in some prescribed form that conforms to the system of accounts that may be in use on his system of railway.

This Committee has eight members, and in order to get anything ready for the next annual meeting that might be called a report, it seems to the Chairman that the best method of procedure would be to assign one or two sub-heads to each member, and, after these reports have been written by the various members, and criticised by the other members, for the Chairman to combine them into the full report, which then should be submitted to each member.

In making its recommendations the Committee should bear in mind that all railways are not organized in the same manner, and that a report that would suit the organization in one case might not do in another.

For this reason the report should be somewhat elastic, so that it will be possible to change the minor details without affecting the value of the recommendations as a whole. The Committee should bear in mind that their report, even if indorsed by the whole Association, will be nothing but a recommendation, and its adoption by the railways will depend largely upon the work that enters into it and the judgment with which this work is directed.

H. F. White, Chief Engineer Burlington, Cedar Rapids & Northern Railroad, Cedar Rapids, Iowa, Chairman;

Jos. Morrison, Resident Engineer Central Vermont, St. Albans, Vt., Vice-Chairman;
L. F. Goodale, Chief Engineer Burlington's Missouri Lines, St. Joseph, Mo.;
T. J. Frazier, Assistant Engineer Baltimore & Ohio Railroad, Zanesville, Ohio;
D. McPherson, Division Engineer Canadian Pacific, Montreal, Can.;
Henry Rohwer, Assistant Engineer Missouri Pacific, Sedalia, Mo.;
George Houliston, Division Engineer Western New York & Pennsylvania Railway, Buffalo, N. Y.;

Committee.

The President:—The subject is now open for discussion.

Mr. R. C. Barnard, Engineer Maintenance-of-Way Pennsylvania Lines West:—I notice that at the bottom of the first page of the report the Committee says: "On looking at the headings into which the subject-matter of this Committee's work has been divided by the Board of Direction, it would seem that to be logical the numbering of the last two heads should be transposed, number three being changed to number two." While making a change in the subjects to be considered, I would suggest that to them be added that of "Wages." This is an important topic, and I do not see that it is covered by any of the various committees, and this one is, in my opinion, the committee to which it should be delegated.

Mr. Whittelsey:—I had in mind the same thing, only in a different way—the name of this Committee, which now reads, "Records, Accounts and Reports," in my judgment, should read, "Reports, Records and Accounts." We first make a record, and report; then we record the report, and afterward we make up our account.

The President:—These suggestions will be considered by the Committee and also by the Board in rearranging the subheading. A little later on the work of this Committee is going to be very important, and while it may be overshadowed by some more important subject which has to come before it, following the outline of what one of the gentlemen has just said, I think we have to make the record, then report, and then account for it. It is so late, if there is nothing further we will excuse the Committee and accept their report and allow them to report at greater length at the next meeting.

The next is the Committee on Signs, Fences, Crossings,

etc. I have the pleasure of introducing Mr. Wilson, the vice-chairman of the Committee.

Mr. Wilson:—This Committee has no report to make, because the Committee has had no meeting, and the chairman has no paper to read, because the chairman, as I understand it, is in Europe. The few remarks that I will make are those simply of the vice-chairman, on the method which will probably be adopted by this Committee, if his suggestions shall be accepted. I think that we have enough subject-matter set out in the organization of this Association to last for a very long time, and it does not seem to me that the Committee should attempt to cover all the subjects that are assigned to it in any one report. Therefore, I think that we should select, perhaps, only a single subject for one year's work, or perhaps two, and possibly only one part of that subject. The subject that should be selected should be the one that would be of the most common interest to all the members or to the railways which they represent. In the listing of the subjects assigned to this Committee it occurs to me that one of the most important is that of highway crossings, and one of the most important subheads is the protection of highway crossings at grade. Under that head should be arranged the various methods of protection in the order of their merit. It seems to me that one subject will be a good deal more than this Committee can accomplish in one year. Coming down to the second subject, it seems to me that we should consider the question of signs. That looks to be very unimportant, but there are certain classes of signs, such as those which are used to notify the trainmen and signs which are used to notify the public, upon which every member of this Association would like to have the indorsement of the Association as to the proper kind of a sign to erect for these purposes. There are other classes of signs which are unimportant and which should be treated in a very superficial way. Such a sign would be a station sign, of which we can hardly recommend a class or a type, because the station sign, like the painting of the coaches, is one which every railroad chooses to select for itself for more reasons than one. Very often it is an advertising feature.

My idea of the Committee's work is simply that the Committee will be as successful as the members of the Association

will make it. Being very largely the mouthpiece of the Association, the chairman of the Committee can do no more than that in which the members of the Committee will assist him in doing. All he can do with the information which they gather up is to present it to the Association, with the views and criticisms of the Committee, and which would be nothing more than the crystallization of the opinion of the members of the Association.

If we get no information from the members of the Association the Committee will do no work. And if the Committee does not work, the chairman has no report to make.

My idea of the method of collecting that information would be to formulate questions and simply arrange these and the answers, and then, perhaps, have one meeting only of the Committee prior to the annual meeting, upon the whole subject. Then the entire matter can be gone over and the report made up and presented. The rest of the work, it seems to me, could be done by correspondence, but there should be at least one meeting of the entire Committee. Even that might not be sufficient unless the Committee itself can do the work, which I believe can be done by correspondence.

The President:—The subject of this Committee is now under consideration. We would be glad to hear from you on it. The question of highway crossings is a very important one and has to do with track elevation matters and overhead crossings, which, in this city, have cost millions of dollars.

Mr. Oborne:—"Cattle-guards" is the most important subject that we know of under the head of the work of this Committee, and I suppose it is really the most important one of the whole list. The representatives of many of the Western roads will bear me out in saying that there are few, if any, positive surface cattle-guards.

The President:—On our road we have a surface guard in some parts of Iowa which is made of wooden slats. We make it at a cost of five or six dollars for each guard, and we have no trouble in keeping the cattle out. In other parts of the country they have very elaborate guards and sometimes they work and sometimes they don't. Down in the South we have the old-fashioned pit guards, and the cattle have learned to walk the rails.

Mr. Whittelsey:—Our West Virginia cattle are educated and furnished with a copy of the schedule.

Mr. McDonald:—I think the proper solution of the question would be to have standard cattle.

Mr. Barnard:—I would suggest to the Committee that they look over the laws of the different States, pertaining to highway crossings, with a view of ascertaining what, if any, protection is afforded the railroads against the opening of new road crossings.

The President:—In some of the States it is specified what the grade should be, and in some of the cities there are regulations relative to the grade crossings. We may spend millions of dollars on grade crossings, and probably a block away the city will open up a street across our grade, and we will be awarded perhaps one dollar damages. It seems to me this Committee has a very wide field to work in to find out not only what the railroads are doing, but the different governments of the city and State organization—what they are doing in the way of assisting and joining with the railroads in eliminating grade crossings. It may be that we may be able to educate the public in territories where they are not educated upon these matters, and thus get their aid in assisting in solving this problem, and in bearing a portion of the expenses. In Chicago the policy is to force the entire expense on the railroad, except as provided in one or two of the later ordinances.

In a few of these cases there is a ray of light in this matter relative to railroad companies, in that they are freed from damages due to the elevation of their track and the construction of their subways. A provision is made that if additional streets are opened it shall not only be done at the expense of the city, but that they shall put up the money before the work is done. As to the streets already existing, it is all put on the railroads. In some of the States it is divided between local governments and the railroads.

In respect to the cattle-guards, the question of what would be a standard cattle-guard is covered by law in some States, and the Committee should look into that question and also into the question as to the stock laws in the different States, and see what bearing that has upon the question of cattle-guards.

Mr. Carothers:—It seems to me that the work of this Committee can be elaborated very much; for instance, they might take up the question of tramps—that comes under the head of the sign, the crossing, the cattle-guard and the other protections.

The President:—Are there any further remarks to make to this Committee about its work, or has the Committee anything further to offer themselves?

This is the last of our Standing Committees, and it seems to me that the Association ought to congratulate itself on the amount of work that we have obtained from these committee chairmen and the members of the committees in the short time they have had to prepare these reports. They were only notified about six weeks ago, and the results that we have received from their work are very gratifying. With the Board of Direction, one of the principles of our organization is that the Board shall attend to all general business of the organization, so that the Association can devote almost all of its time to the general direction of the work and the discussion of the papers.

I presume that we should have a motion receiving these reports and thanking the committees for the work that they have done. We do not discharge them, however, for they are permanent Standing Committees, and we should refer the reports to the Publication Committee for auditing and printing. Last night the Committee authorized the printing of the reports received yesterday, and they will be printed and forwarded to the individual members at an early date.

Is there any motion before the house with reference to this? If there are no objections I will consider that motion made and seconded.

The motion was unanimously carried.

Mr. McNab:—May I be allowed a few moments. It occurs to me that there are many members of this Association who are also members of the American Society of Civil Engineers, and on looking over the transactions of that body for some years back, one finds quite a number of papers referring to railway matters and to maintenance-of-way matters generally. I think it would be a graceful tribute to this Association if any of our members had intended to write a paper for that society

on a railway subject, that it should be tendered to this Association instead. To-day I had the offer from a distinguished member of your Board of Direction to furnish details to the Committee of which I am a member, of a paper which he had at first intended to present to that society. I merely throw this out as a suggestion that the Chairman might lay before the meeting.

The President:—I am in a very delicate position in this matter, inasmuch as I happen to be the president of that society. I think the suggestion is very valuable, however, and members ought to consider the importance of presenting papers to this organization in the same way that they are presented to other engineering organizations, on any subject they see fit, and after these papers are read they can be referred to the appropriate committee and considered and discussed by that committee and form a part of their report, and be transmitted to the Association with their report at the next annual meeting.

If there is nothing further before the house the Secretary will make known the result of the election.

The Secretary:—Death has claimed four members of this Association during the past year, and a page in our publication will be set aside for the publication of their names and suitable memorials.

The President:—I would like to state that it would be eminently proper for us to publish a short memoir of these gentlemen. I was not acquainted with them. Their friends among our members should prepare a short memoir and furnish it to the Secretary, so it can be published. I would appoint committees to do that if I were acquainted with the names of the proper persons to appoint who are friends of these men.

The Secretary:—The result of the election is as follows:

For President—Mr. J. F. Wallace, of the Illinois Central Railroad, received 153 votes.

Mr. S. M. Felton, Chicago & Alton Railroad, who received one vote.

Mr. J. Kruttschnitt, Southern Pacific Company, who received one vote.

Mr. Wallace is elected.

For First Vice-President, for one year—Mr. P. A. Peterson, Canadian Pacific Railway, who received 155 votes.

For Second Vice-President, for two years—Mr. W. G. Curtis, Southern Pacific Company, who received 155 votes.

For Secretary—Mr. L. C. Fritch, Baltimore & Ohio Southwestern Railroad, who received 155 votes.

For Treasurer—Mr. W. S. Dawley, Chicago & Eastern Illinois Railroad, who received 155 votes.

For Directors for one year—Mr. W. K. McFarlin, Delaware, Lackawanna & Western, who received 155 votes, and Mr. Hunter McDonald, Nashville, Chattanooga & St. Louis, who received 155 votes.

For Directors for two years—Mr. D. J. Whittemore, Chicago, Milwaukee & St. Paul, who received 155 votes, and Mr. F. H. McGuigan, Grand Trunk, who received 155 votes.

For Directors for three years—Mr. A. Torrey, Michigan Central, who received 155 votes, and Mr. Thomas Rodd, Pennsylvania Lines West, who received 155 votes.

C. A. Wilson,
E. C. Macy,
C. Dougherty.

The President:—There was some hesitancy about accepting the re-election—we declined at first, but the Board insisted that we accept, and it may be all right this time, but it reminds me of the experience I had when in college. A member of our class failed to show up one morning—it was just at the close of recitation (he had served in the army and was a cripple, and when he came in the boys used to call him Mr. Flat Wheel). He was a married man, and when he came in he whispered to the professor, in a stage whisper: "Professor, I had an occurrence in my family that prevented my getting here earlier to-day. It's a boy." The professor said: "All right, Mr. Nichols; it's all right this time, but never let it happen again."

Mr. W. G. Curtis, Southern Pacific Company:—I want to offer a resolution, and in so doing express the sentiments of the other gentlemen here. The resolution is as follows:

"Resolved, That the most appreciative thanks of this Association are due and are hereby extended to the President, Mr. J. F. Wallace, and to the Secretary, Mr. L. C. Fritch, for their untiring efforts in organizing and fostering the interests of this Association."

The resolution was unanimously adopted.

Mr. Curtis also offered the following resolution:

"Be it resolved, That a vote of thanks to Mr. J. M. Barr, of the Santa Fe Railroad, be extended to him for his kindness in furnishing a train for the members of this Association on their trip to Joliet."

This resolution was also adopted unanimously.

On motion, the meeting adjourned sine die.

CONSTITUTION.

ARTICLE I.

Name, Location, Object and Means.

Section 1. Name: The name of this Association shall be The American Railway Engineering and Maintenance-of-Way Association.

Section 2. Location: The offices of the Association shall be located in Chicago, Illinois.

Section 3. Object: The object of this Association shall be the advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railroads.

Section 4. Means: The means to be employed for this purpose shall be as follows:

(*a*) Meetings for the reading and discussion of papers and for social intercourse.

(*b*) The investigation of matters pertaining to the Objects of this Association through Standing and Special Committees.

(*c*) The publication of papers, reports and discussions.

(*d*) The maintenance of a library.

ARTICLE II.

Membership.

Section 1. The Membership of this Association shall be divided into two classes, viz., Active and Honorary.

Section 2. Any Civil, Mechanical or Electrical Engineer, who has had five years' experience in the location, construction or maintenance of railroads; and any railroad official who is responsible for or has supervision of maintenance-of-way matters (embracing all grades of officials, from General Managers to Engineers of Maintenance-of-Way in charge of Divisions

inclusive), or railroad men bearing other titles but performing similar duties, shall be eligible for Active Membership.

SECTION 3. An Honorary Member shall be a person of acknowledged eminence in Railway Engineering or management. The number of Honorary Members shall be limited to ten. Honorary Members shall have all the rights of Active Members, except those of voting and holding office.

SECTION 4. Persons who are exclusively engaged in the sale or promotion of railroad patents or appliances shall not be eligible for membership in this Association.

ARTICLE III.

ADMISSIONS AND EXPULSIONS.

SECTION 1. The Charter Membership shall consist of all persons who are eligible for Membership under the provisions of Article II, and who may make application to the Secretary of the Preliminary Organization and receive a majority of the votes of the Organization Committee (composed of the Chairman and Secretary of the Preliminary Organization and the five persons constituting the Committee to prepare a Constitution and By-Laws), and pay the entrance fee, hereinafter provided for, within thirty days from the date of the adoption of this Constitution.

SECTION 2. After the expiration of said thirty days persons desiring Membership shall make application on the form prescribed by the Board of Direction, referring to five Members. The Board of Direction, through its Secretary or a Committee on Applications, shall make such investigations of the candidate's fitness as may be deemed necessary. The Secretary of the Association will furnish copies of the information obtained, together with a copy of the application, to each member of the Board of Direction. At any time, thirty days after the filing of the application, the admission of the applicant shall be voted on by the letter ballot by each Member of the Board of Direction. Affirmative votes by two-thirds of the Board of Direction shall elect the candidates.

SECTION 3. All elected candidates shall be duly notified, and shall subscribe to the Constitution and By-Laws, on forms prescribed by the Board of Direction, and transmit to the Sec-

retary the entrance fee hereinafter prescribed. If this provision be not complied with within six months the election shall be considered null and void.

SECTION 4. Honorary Members shall be proposed by at least ten Active Members to the Secretary. Each Member of the Board of Direction shall be furnished with a copy of the proposal, and after thirty days votes by ballot shall be taken by the Board of Direction thereon. If a candidate shall receive the unanimous vote of said Board he shall be declared elected an Honorary Member.

SECTION 5. Expulsions: On written charges preferred by ten or more Members, addressed to the Secretary of the Association, the Member complained of shall be served with a copy of said charges, and shall be called upon to show cause to the Board of Direction why he should not be expelled from the Association. Thirty days after said Member has been properly notified of the charges preferred against him, a vote shall be taken on his expulsion, and he may be expelled upon a two-thirds vote of the Board of Direction.

SECTION 6. Resignations: It shall be the duty of the Board of Direction to accept the resignation, tendered in writing, of any Member whose dues are fully paid up.

ARTICLE IV.

DUES.

SECTION 1. An initiation fee of $10.00 shall be payable to the Secretary with each application for Membership; this sum is to be returned to the applicant, however, who is not elected.

SECTION 2. The annual dues of this Association shall be $10.00, payable annually, during the first three months of each calendar year for the current year.

SECTION 3. Any person whose dues remain three months in arrears shall be notified of same by the Secretary. Should the dues in arrears not be paid prior to July 1st of each year, the delinquent Member shall lose his right to vote, but shall continue to receive the publications of the Association. Should his dues become nine months in arrears he shall be notified on the form prescribed by the Board of Direction; and if said

dues are not paid by the first of the following year, he shall forfeit his connection with the Association without further action.

SECTION 4. The Board of Direction may, however, extend the time of payment of dues and for the application of these penalties. The Board of Direction may also, for sufficient cause, excuse from payment the annual dues of any Member who, from ill health, advanced age or other good reason, is unable to pay his dues.

ARTICLE V.

OFFICERS.

SECTION 1. The officers of this Association shall consist of a President, two Vice-Presidents, six Directors, a Secretary and a Treasurer, who shall constitute the Board of Direction, in which the Government of the Association shall be vested; and who also shall act as Trustees and have the custody of all property belonging to the Association.

SECTION 2. The term of office of the President, Secretary and Treasurer shall be one year; of the Vice-Presidents two years, and of the Directors three years, with the exception, however, that at the first election of Officers after the adoption of this Constitution one Vice-President and two Directors shall be elected to serve one year; one Vice-President and two Directors for two years, and two Directors for three years; provided also, that after the first annual election one Vice-President and two Directors shall be elected each year in addition to the President, Secretary and Treasurer.

SECTION 3. The first election of officers under this Constitution shall be held by the Preliminary Organization of Charter Members immediately after the adoption of this Constitution, and the Officers so elected shall at once assume office. The term of each Officer shall begin at the close of each election and shall continue until his successor shall be elected at the expiration of his term as above set forth.

SECTION 4. Any vacancy in the office of President shall be filled by the senior Vice-President. A vacancy in the office of Vice-President shall be filled by election from among the Directors. In case of the disability or neglect in the performance of his duty of any Officer of this Association, the Board

of Direction shall have power to declare the office vacant. Vacancies in any office for the unexpired term shall be filled by the Board of Direction, except vacancy in office of President, as provided above.

SECTION 5. At least thirty days before each annual meeting, the Board of Direction, who shall act as a Nominating Committee, shall nominate to the Association a list of Officers for the next ensuing year. At any time prior to the thirty days before the annual meeting any ten Members of the Association shall have the right to nominate Officers for the ensuing year. Thirty days prior to each annual meeting the Secretary shall issue ballots to each Member of record in good standing, with a list of the several candidates to be voted upon, whose names shall be placed in alphabetical order if more than one person is nominated for any position. Ballots shall be placed in a sealed envelope, with the name of the Member voting indorsed thereon, and deposited with the Secretary at any time previous to the annual meeting. At the annual meeting three tellers shall be appointed, who shall open and count the ballots and report the result thereof. The majority of votes cast for any nominee shall determine his election.

ARTICLE VI.

MANAGEMENT.

SECTION 1. The President shall have a general supervision of the affairs of the Association. He shall preside at all meetings of the Association and at all meetings of the Board of Direction, and shall be ex-officio Member of all Committees.

The Vice-Presidents in order of seniority shall preside at meetings in the absence of the President, and discharge his duties in case of a vacancy in his office.

SECTION 2. The Board of Direction shall manage the affairs of the Association and shall have full power to control and regulate all matters not otherwise provided for in the Constitution.

SECTION 3. The Treasurer shall receive all moneys and deposit same in the name of the Association, and shall receipt to the Secretary therefor. He shall invest all funds not needed for current disbursements as shall be ordered by the Board of

Direction. He shall pay all bills, when properly certified and audited by the Board of Direction, and make such reports as may be called for by the Board of Direction.

SECTION 4. The Secretary shall be, under the direction of the President and Board of Direction, the Executive Officer of the Association. He shall attend all meetings of the Association and of the Board of Direction; prepare the business therefor, and duly record the proceedings thereof. He shall see that all moneys due the Association are carefully collected, and without loss transferred to the custody of the Treasurer. He shall personally certify to the accuracy of all bills or vouchers on which money is to be paid. He is to conduct the correspondence of the Association and keep a proper record thereof; and perform such other duties as may be assigned to him from time to time by the Board of Direction.

ARTICLE VII.

COMMITTEES.

SECTION 1. The Board of Direction shall meet within ten days after each annual meeting, and shall appoint from among its Members a Finance Committee of three, a Library Committee of three and a Committee on Publications of three. These Committees shall report to the Board of Direction and perform their duties under its supervision.

SECTION 2. The Finance Committee shall have immediate supervision of the accounts and financial affairs of the Association; shall approve all bills before payment, and shall make recommendations to the Board of Direction as to the investment of moneys and as to other financial matters.

SECTION 3. The Library Committee shall have general supervision of the Library of the Association and property therein.

SECTION 4. The Committee on Publications shall have general supervision of the publications of the Association.

SECTION 5. The Board of Direction may appoint such Standing Committees as it may deem best, to investigate, consider and report upon methods or appliances pertaining to the general question of railroad location, construction or maintenance.

SECTION 6. Special Committees to examine into and report upon any subject connected with the purposes of this Association may be appointed in the following manner:

A resolution to appoint such Committee, setting forth its objects and the number of its Members, may be presented by letter at any time to the Secretary of the Association, if signed by ten Active Members, and shall be referred by him to the Board of Direction, which, if it sees fit, may appoint such Committee. If the Board of Direction should not deem it expedient to appoint such Committee, the Members requesting the appointment of such Committee shall be notified, and the matter will then be referred to the Association at its next annual meeting and decided upon by ballot. If two-thirds of the Members present vote in favor of such Committee it shall be appointed by the President.

ARTICLE VIII.

MEETINGS.

SECTION 1. The annual meeting shall be held each year at such place and at such time as may be selected by the Board of Direction. Twenty-five Active Members shall constitute a quorum. Other meetings of the Association may be held at such times and at such places as the Board of Direction may select. The Secretary shall notify all Members of the time and place of all meetings of the Association at least thirty days in advance thereof.

SECTION 2. The Board of Direction shall meet at such times and at such places as a majority of the Board may determine. Five Members of the Board of Direction shall constitute a quorum.

SECTION 3. The order of business at meetings of the Association shall be as follows:

1. Reading of Minutes of last meeting.
2. Address of the President.
3. Admission of new Members.
4. Reports of the Secretary and Treasurer.
5. Reports of Standing Committees.
6. Reports of Special Committees.
7. Unfinished business.

8. New business.
9. Reading of papers and discussion thereof.
10. Election of Officers.
11. Adjournment.

This order of business, however, may be varied from, on a majority vote of Members present at any meeting.

ARTICLE IX.

Amendments.

Section 1. Proposed amendments to this Constitution must be made in writing and signed by not less than ten Active Members, and shall be acted upon in the following manner:

The amendments shall be presented to the Secretary, who shall send a copy of same to each Member of the Board of Direction as soon as received. If at the next meeting of the Board of Direction a majority of the Board are in favor of considering the proposed amendment, the matter shall then be submitted by letter to each Active Member of the Association for voting by ballot, and the result announced by the Secretary at the next annual meeting of the Association. In case two-thirds of the votes received are affirmative, the amendment shall be declared adopted. Amendments so adopted shall take effect thirty days thereafter.

LIST OF OFFICERS.

1900.

PRESIDENT.

J. F. WALLACE, Illinois Central Railroad, Chicago, Ill.

FIRST VICE-PRESIDENT—ONE YEAR.

P. A. PETERSON, Canadian Pacific Railway, Montreal, Can.

SECOND VICE-PRESIDENT—TWO YEARS.

W. G. CURTIS, Southern Pacific Company, San Francisco, Cal.

SECRETARY.

L. C. FRITCH, Baltimore & Ohio Southwestern Railroad, Washington, Ind. (Office, 1562 Monadnock, Chicago, Ill.)

TREASURER.

W. S. DAWLEY, Chicago & Eastern Illinois Railroad, Chicago, Ill.

DIRECTORS.

For Three Years.

A. TORREY, Michigan Central Railroad, Detroit, Mich.
THOS. RODD, Pennsylvania Lines West of Pittsburg, Pittsburg, Pa.

For Two Years.

D. J. WHITTEMORE, Chicago, Milwaukee & St. Paul, Chicago, Ill.
F. H. MCGUIGAN, Grand Trunk Railway, Montreal, Can.

For One Year.

W. K. MCFARLIN, Delaware, Lackawanna & Western, Hoboken, N. J.
HUNTER MCDONALD, Nashville, Chattanooga & St. Louis, Nashville, Tenn.

COMMITTEES OF THE BOARD OF DIRECTION.

ON FINANCE.

F. H. MCGUIGAN, Grand Trunk Railway, Chairman.
D. J. WHITTEMORE, Chicago, Milwaukee & St. Paul Railway.
W. S. DAWLEY, Chicago & Eastern Illinois Railroad.

On Publications.

A. Torrey, Michigan Central Railroad, Chairman.
P. A. Peterson, Canadian Pacific Railway.
W. G. Curtis, Southern Pacific Company.
L. C. Fritch, Baltimore & Ohio Southwestern Railroad.

On Library.

Thos. Rodd, Pennsylvania Lines West, Chairman.
W. K. McFarlin, Delaware, Lackawanna & Western.
Hunter McDonald, Nashville, Chattanooga & St. Louis Railway.

LIST OF STANDING COMMITTEES AND OUTLINE OF COMMITTEE-WORK.

I.—GRADUATION.

J. B. Berry, Chief Engineer Union Pacific, Omaha, Neb., Chairman.
W. McNab, Assistant Engineer Grand Trunk, Montreal, Vice-Chairman.
J. A. Atwood, Chief Engineer Pittsburg & Lake Erie, Pittsburg, Pa.
R. C. Barnard, Engineer Maintenance-of-Way Pennsylvania Lines West, Cincinnati, O.
Geo. M. Brown, Chief Engineer Saginaw District Pere Marquette Railway, Saginaw, Mich.
H. Baldwin, Engineer Maintenance-of-Way Cleveland, Cincinnati, Chicago & St. Louis Railway, Indianapolis, Ind.
C. Dougherty, Roadmaster Illinois Central Railroad, Chicago;

Committee.

1. Cuttings and Embankments:
   - *a* Standard cross-sections (variations of same, affected by local conditions).
2. Protection of Slopes:
   - *a* Sodding;
   - *b* Paving;
   - *c* Refaining walls;
   - *d* Planting willows, etc.;
   - *e* Sand-bagging;
   - *f* Drainage by surface ditches above, below, and on slopes, and by tiling.
3. Improvement of Grades and Alignment:
   - *a* Methods used;
   - *b* Limit of economy;
   - *c* Steam-shovel work.
4. Tunnels:
   - *a* Ventilation;
   - *b* Maintenance.

II.—BALLASTING.

R. Montfort, Chief Engineer Louisville & Nashville, Louisville, Chairman;
W. H. Peddle, General Superintendent Maintenance Southern Railway, Washington, D. C., Vice-Chairman;
A. Mordecai, Assistant Chief Engineer Erie Railroad, Cleveland, Ohio;
J. R. Leighty, Roadmaster Chicago & North-Western, Carroll, Iowa;
Edward Shelah, General Roadmaster Wabash Railroad, Decatur, Ill.;
J. T. Richards, Engineer Maintenance-of-Way Pennsylvania Railroad, Philadelphia, Pa.
H. U. Wallace, Division Superintendent Illinois Central, Freeport, Ill.;
Committee.

1. Material:
   - *a* Stone—Size, quality;
   - *b* Gravel—Cementing, loose, sandy;
   - *c* Burnt clay—Quality, method of burning, etc.;
   - *d* Slag, cinder, and burnt shale;
   - *e* Chatts—Character;
   - *f* Earth;
   - *g* Dust prevention.
2. Standard cross-sections (variations, modified by material and other conditions).
3. Cost:
   - *a* Material alone;
   - *b* Loading;
   - *c* Transportation;
   - *d* Unloading;
   - *e* Placing under track; surfacing and dressing.
4. Methods:
   - *a* Handling material;
   - *b* Keeping trace of cost and accounts.
5. What constitutes ballasted track.

III.—TIES.

J. Kruttschnitt, Vice-President and General Manager Southern Pacific, San Francisco, Cal., Chairman;
G. W. Kittredge, Chief Engineer Cleveland, Cincinnati, Chicago & St. Louis, Cincinnati, Ohio, Vice-Chairman;
J. J. Frey, President Florence & Cripple Creek Railway, Denver, Colo.;
W. L. Darling, Assistant Chief Engineer Northern Pacific, St. Paul, Minn.;
O. Chanute, Consulting Engineer, Chicago;
Wm. Archer, Principal Assistant Engineer Baltimore & Ohio Southwestern Railroad, Cincinnati, Ohio;
W. C. Cushing, Engineer Maintenance-of-Way Pennsylvania Lines West, Pittsburg, Pa.;

Lewis Kingman, Chief Engineer Mexican Central Railway, Mexico, Mex.;
J. C. Nelson, Division Engineer New York Central, New York;
Committee.

1. Material:
   - *a* Wood—Various kinds;
   - *b* Metal—Shapes, etc.
2. Preservation:
   - *a* Consideration of methods and cost.
3. Inspection:
   - *a* When purchasing;
   - *b* When necessary to renew in track.
4. Cost:
   - *a* Delivered at side of track;
   - *b* Loading;
   - *c* Transportation;
   - *d* Local distribution;
   - *e* Putting in track and spacing.
5. Disposition of old ties:
   - *a* Method and cost of utilizing same;
   - *b* Use for firewood;
   - *c* Use for curbing, retaining walls and otherwise;
   - *d* Burning.
6. Methods:
   - *a* Handling tie question;
   - *b* Reports and accounts.
7. General questions:
   - *a* Preparing for track;
   - *b* Piling for use;
   - *c* Boring for spikes;
   - *d* Planing or adzing for tie-plates;
   - *e* Lining up on ends;
   - *f* Marking for age in service;
   - *g* Tie-plates.

IV.—RAIL.

Robt. Trimble, Principal Assistant Engineer Pennsylvania Lines West, Pittsburg, Pa., Chairman;
S. M. Felton, President Chicago & Alton Railroad, Chicago, Vice-Chairman;
A. W. Johnston, General Superintendent New York, Chicago & St. Louis, Cleveland, Ohio;
Thos. Purcell, Superintendent Mexican National Railway, Matamoros, Mexico;
W. T. Manning, Consulting Engineer Baltimore & Ohio Railroad, Baltimore, Md.;
R. W. Hunt, Consulting Engineer, Chicago;
C. E. Wickham, Division Engineer Chicago, Rock Island & Pacific, Chicago;

J. H. WALLACE, Assistant Engineer Maintenance-of-Way Southern Pacific, San Francisco, Cal.;
G. B. WOODWORTH, Rail Inspector Chicago, Milwaukee & St. Paul Railway, Chicago;

Committee.

1. General specifications:
   - *a* Chemical constituents;
   - *b* Mechanical manipulation;
   - *c* Inspection.
2. Standard sections:
   - *a* As to general form, considering differences of section as related to alignment, grades and traffic;
   - *b* As to weight, considering adoption of standard section of weight per yard.
3. Proper length of rails—reasons therefor.
4. Transportation.
5. Local distribution and handling.
6. Laying:
   - *a* Methods, single rails or strings;
   - *b* Expansion;
   - *c* Adzing ties, preparatory to laying.
7. Utilization of relieved rail:
   - *a* For patching rail of same kind in main line;
   - *b* For laying on branch lines;
   - *c* Passing tracks and sidings;
   - *d* Scrap;
   - *e* Care and treatment of relieved rail (re-rolling and careful sawing).

V.—TRACK.

E. A. HANDY, Chief Engineer Lake Shore & Michigan Southern, Cleveland, Ohio, Chairman;
H. F. BALDWIN, Chief Engineer Chicago & Alton, Chicago, Vice-Chairman;
S. B. FISHER, Chief Engineer Missouri, Kansas & Texas Railway, St. Louis, Mo.;
W. W. GWATHMEY, Jr., Chief Engineer Seaboard Air Line, Portsmouth, Va.;
A. S. CHEEVER, Chief Engineer Fitchburg Railroad, Boston, Mass.;
WM. B. POLAND, Division Engineer Baltimore & Ohio Southwestern, Washington, Ind.;
G. S. CHEYNEY, Assistant Division Engineer New York Central, Buffalo, N. Y.;
J. B. MOLL, General Roadmaster Chicago, Milwaukee & St. Paul, Chicago;
J. B. ROBINSON, Resident Engineer Southern Pacific Company, Sacramento, Cal.;
H. C. LANDON, Chief Engineer Buffalo & Susquehanna, Austin, Pa.;

Committee.

1. Maintenance of Line:
   - *a* Adjustment of tangents;
   - *b* Adjustment of curves, with consideration as to easement of curves;
   - *c* Methods used in securing and maintaining perfect line.
2. Maintenance of Surface:
   - *a* Elevation of curves, with special consideration as to amount and beginning and end of elevation, and as modified by location of curve and conditions of traffic;
   - *b* Vertical curves;
   - *c* Proper methods of tamping.
3. Maintenance of Gauge:
   - *a* Proper method of spiking;
   - *b* Allowance, if any, in gauge of curves, with consideration as to various practices;
   - *c* Methods used to prevent spreading of track and canting of rails.
4. Inspection of Track:
   - *a* Trackwalking, consideration as to when resorted to, and particular requirement of;
   - *b* Special inspection of switches, frogs, crossings, derailing points, interlocking plants, etc.; requirements;
   - *c* Inspection of bridges, trestles, culverts, etc., by trackmen.
5. Tools:
   - *a* Track tools, various kinds;
   - *b* Standard equipment for gangs;
   - *c* Hand-cars—types and use;
   - *d* Push-cars—types and use;
   - *e* Dump-cars;
   - *f* Method used in supplying and checking use of.
6. Frogs and Switches:
   - *a* Types for main line;
   - *b* Types for yards;
   - *c* Best angle for main line;
   - *d* Safety devices in connection therewith.
7. Crossings:
   - *a* Foundations and drainage;
   - *b* Types of crossings.
8. Guard-rails:
   - *a* Spacing of flange-way;
   - *b* Foot-guard protection.
9. Joints and Fastenings.
10. General Questions:
    - *a* Cleaning track;
    - *b* Cutting right-of-way, consideration as to time, etc.;
    - *c* Care of station grounds;
    - *d* Painting, white-washing, dressing up, etc.

VI.—BUILDINGS.

W. G. Berg, Chief Engineer Lehigh Valley Railroad, New York City, Chairman;
H. W. Parkhurst, Engineer Bridges and Buildings Illinois Central, Chicago, Vice-Chairman;
P. D. Ford, Chief Engineer Long Island Railroad, Richmond Hill, N. Y.;
E. C. Macy, Engineer Iowa Central, Marshalltown, Iowa;
C. E. Bryan, Superintendent Maintenance-of-Way Ohio River Railroad, Parkersburg, W. Va.;
C. Millard, General Manager Chicago, Peoria & St. Louis Railway, Springfield, Ill.;
B. C. Gowen, Chief Engineer Wisconsin & Michigan, Wausau, Wis.;
M. W. Cooley, Assistant Engineer Baltimore & Ohio, Baltimore, Md.;
A. S. Markley, Superintendent Bridges and Buildings Chicago & Eastern Illinois, Danville, Ill.;
C. T. Norton, Superintendent Mexican International Railway, Porfirio Diaz, Mexico;
H. Pierce, Engineer Maintenance-of-Way Chesapeake & Ohio, Huntington, W. Va.;
I. F. White, Superintendent Tracks and Structures Cincinnati, Hamilton & Dayton Railway, Hamilton, Ohio;
G. W. Vaughan, Supervisor Bridges and Buildings, New York Central, New York, N. Y.;
J. D. Isaacs, Second Assistant Engineer Maintenance-of-Way Southern Pacific, San Francisco, Cal.;

Committee.

1. Passenger Station Buildings:
   a Material;
   b Standard plans.
2. Freight Station Buildings:
   a Material;
   b Standard plans.
3. Combination Stations.
4. Machine Shops (including engine-erecting, boiler, blacksmith, paint, car-building and repair-shop buildings, dry houses, transfer tables, etc.).
5. Round-houses (including turntables, engine pits, drop pits, cinder pits, etc.);
   Manner of handling cinders.
6. Coaling Stations:
   a Method of handling coal;
   b Cost per ton to handle.
7. Sand and Oil Houses.
8. Coal-houses for stations; watch-boxes; scale-houses; interlocking towers; water stations; icing stations.
9. Water tanks, pump-houses and track tanks.

10. Platforms:
    - *a* Wooden;
    - *b* Cement;
    - *c* Brick;
    - *d* Stone;
    - *e* Cinder.
11. Elevators:
    - *a* Transfer;
    - *b* Storage;
    - *c* Clipping and cleaning.
12. General Questions:
    - *a* Painting;
    - *b* Inspection of;
    - *c* Fire protection;
    - *d* Lighting plants and methods;
    - *e* Heating methods.

VII.—BRIDGES AND TRESTLES.

ONWARD BATES, Engineer and Superintendent Bridges and Buildings Chicago, Milwaukee & St. Paul, Chicago, Chairman;
W. A. MCGONAGLE, Resident Engineer and Superintendent Bridges and Buildings Duluth & Iron Range Railroad, Duluth, Minn., Vice-Chairman;
A. ZIESING, Consulting Engineer, Chicago;
I. O. WALKER, Division Engineer Nashville, Chattanooga & St. Louis, Paducah, Ky.;
E. BARRINGTON, Principal Assistant Engineer Vera Cruz & Pacific Railway, Mexico, Mex.;
R. MODJESKI, Consulting Engineer, Chicago;
D. W. LUM, Assistant General Superintendent Maintenance Southern Railway, Washington, D. C.;
B. DOUGLAS, Bridge Engineer Michigan Central Railroad, Detroit, Mich.;
WILLIAM MICHEL, Engineer Maintenance-of-Way Hocking Valley Railroad, Columbus, Ohio;
T. L. CONDRON, Civil Engineer, Chicago;

Committee.

1. Iron Bridges:
    - *a* Rolled I-beam spans; consideration as to limit of economical use;
    - *b* Plate girders; consideration as to limit of economy in their use;
    - *c* Truss spans; consideration as to various types;
    - *d* Draw spans; consideration as to method of operation.
2. Wooden Bridges:
    - *a* Character and various types;
    - *b* Method of protection or care.

3. Trestles:
   a Iron; consideration as to comparative cost with wooden trestles;
   b Pile; length of spans; character and specifications of piling; protection in salt water; protection at ground line; limit of use; filling;
   c Frame bents; construction; bracing; custom in renewal, whether in whole or in part; filling;
   d Solid floor trestles.
4. Docks and Wharves:
   a Coal docks;
   b Ore docks;
   c Piers and slips;
   d Transfer facilities.
5. Miscellaneous:
   a Cost per foot—various types;
   b Inspection—practice regarding;
   c Painting—best method of protection from rust.

VIII.—MASONRY.

W. L. Breckinridge, Chief Engineer Chicago, Burlington & Quincy, Chicago, Chairman;
E. P. Dawley, Division Engineer New York, New Haven & Hartford, Boston, Mass., Vice-Chairman;
William Hood, Chief Engineer Southern Pacific, San Francisco, Cal.;
H. G. Kelley, Chief Engineer Minneapolis & St. Louis, Minneapolis, Minn.;
W. E. Hoyt, Consulting Engineer, Rochester, N. Y.;
F. S. Stevens, Division Engineer Philadelphia & Reading, Reading, Pa.;
C. F. W. Felt, Chief Engineer Gulf, Colorado & Santa Fe, Galveston, Texas;
B. T. Fendall, City Engineer, Baltimore, Md.;
F. M. Bisbee, Superintendent Track, Bridges and Buildings St. Louis & San Francisco, Springfield, Mo.;
Committee.

1. Bridge Masonry:
   a Abutments; various forms and economies resulting therefrom;
   b Piers, including foundations, coping, etc.; also cost of low piers, with use of steel bents, as against full-height piers;
   c Bridge seats, mud walls, wing walls, etc.
2. Arch Masonry:
   a Various types and advantages of same relative to local conditions;
   b Practice of use of arches in "T" abutments to save masonry;
   c Limit of economy in use as against span bridges.
3. Culvert Masonry:
   a Forms of;
   b Cover-plates, wall-plates, paving;
   c Use of rails for cover-plates, with brick or concrete in spaces.

4. Pipe Culverts:
   a Iron, water and gas pipes, considering foundations used in laying, thickness of pipe; limit of use as to number of lines of pipe and diameter;
   b End walls.
5. Wooden Box Drains:
   a When permitted.
6. Concrete Masonry.

IX.—SIGNS, FENCES, CROSSINGS AND CATTLE-GUARDS.

H. Fernstrom, Chief Engineer Chicago Great Western, St. Paul, Minn., Chairman;
C. A. Wilson, Chief Engineer Cincinnati, Hamilton & Dayton, Cincinnati, Ohio, Vice-Chairman;
G. F. Bidwell, General Manager Fremont, Elkhorn & Missouri Valley, Omaha, Neb.;
D. Bontecou, Chief Engineer Kansas City, Fort Scott & Memphis, Kansas City, Mo.;
J. R. W. Davis, Engineer Maintenance-of-Way Erie Railroad, Jersey City, N. J.;
H. J. Slifer, Superintendent Chicago & North-Western, Boone, Iowa;
W. Shepard, Chief Engineer Boston & Albany, Boston, Mass.;

1. Fences: *Committee.*
   a Wire—various kinds;
   b Posts used in wire fences;
   c Board fences;
   d Method regarding maintenance;
   e Snow fences.
2. Highway Crossings:
   a Overhead crossings;
   b Under crossings;
   c Surface crossings—consideration as to protection of same; planking; approaches;
   d Crossing gates—pneumatic, hydraulic, electrical or physical operation.
3. Cattle-guards:
   a Surface guards;
   b Pit guards;
   c Wing fences, to cattle-guards.
4. Signs:
   a Standard station signs;
   b Standard ring whistle posts;
   c Standard mile-posts;
   d Standard highway-crossing warnings;
   e Standard stop sign boards;
   f Standard yard-limit boards;
   g County, city-limit and state-line boards;
   h Bridge warnings;
   i Structure signs—method of indicating.

X.—SIGNALING AND INTERLOCKING PLANTS.

H. D. Miles, Signal Engineer Michigan Central Railroad, Detroit, Mich., Chairman;

F. W. Scarborough, Engineer Bridges and Signals Chesapeake & Ohio, Richmond, Va., Vice-Chairman;

W. J. Gillingham, Jr., Signal Engineer Illinois Central, Chicago;

J. S. Hobson, Signal Engineer Atchison, Topeka & Santa Fe Railroad, Topeka, Kan.;

A. H. Sanford, Engineer Maintenance-of-Way Pennsylvania Lines West, Toledo, Ohio;

Committee.

1. Signals:
   - *a* Train-order signals;
   - *b* Distance signals;
   - *c* Block signals.
2. Interlocking Plants:
   - *a* Railway crossings protection;
   - *b* Switch connections;
   - *c* Operating yards.
3. Highway Crossings Signals:
   - *a* Various types;
   - *b* Mode of operation.
4. Miscellaneous Questions.

XI.—REPORTS, RECORDS AND ACCOUNTS.

H. F. White, Chief Engineer Burlington, Cedar Rapids & Northern, Cedar Rapids, Iowa, Chairman;

Joseph Morrison, Resident Engineer Central Vermont Railway, St. Albans, Vt., Vice-Chairman;

L. F. Goodale, Chief Engineer Burlington's Missouri Lines, St. Joseph, Mo.;

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D. McPherson, Division Engineer Canadian Pacific, Montreal, Canada;

Henry Rohwer, Assistant Engineer Missouri Pacific, Sedalia, Mo.;

George Houliston, Division Engineer Western New York & Pennsylvania Railway, Buffalo, N. Y.;

Committee.

1. Reports:
   - *a* Labor reports, including method of reporting time worked, with classification of items, with a view of reaching uniformity in this regard;
   - *b* Material reports—various forms used in reporting material used to enable complete check to be had on all material used;
   - *c* Miscellaneous reports, such as accident, fire claims, stock killed, flood damage, etc.

2. Records:
   a Right-of-way records, deed records;
   b Station plats;
   c Profiles of road;
   d Alignment maps;
   e Lease records.
3. Accounts:
   a Labor accounts; consideration as to classification of distribution to various items of labor;
   b Material accounts; consideration as to method of charging out to various classes of work; whether individual accounts with each structure or general accounts;
   c Bills against other lines.

XII.—UNIFORM RULES, ORGANIZATION, TITLES, CODE, ETC.

D. D. Carothers, Engineer Maintenance-of-Way Baltimore & Ohio Southwestern Railroad, Cincinnati, Ohio, Chairman;
W. J. Wilgus, Chief Engineer New York Central & Hudson River Railroad, New York, Vice-Chairman;
E. H. Fitzhugh, General Manager Central Vermont Railway, St. Albans, Vt.;
G. A. Quinlan, Vice-President and General Manager Houston & Texas Central Railroad, Houston, Texas;
James Oborne, General Superintendent Canadian Pacific, Winnipeg, Man.;
T. F. Whittelsey, General Superintendent Toledo & Ohio Central Railway, Toledo;
C. S. Churchill, Engineer Maintenance-of-Way Norfolk & Western, Roanoke, Va.;
J. T. Mahl, Engineer Maintenance-of-Way Southern Pacific, Houston, Texas;
F. B. Harriman, Superintendent Illinois Central, Dubuque, Iowa;

Committee.

1. Proper Organization of the Maintenance-of-Way Department.
2. Code of titles, applicable uniformly over entire country.
3. Rules and Regulations governing employes in Maintenance-of-Way Department.
4. Code of Maintenance-of-Way Ethics.

XIII.—WATER SERVICE.

W. E. Dauchy, Chief Engineer Chicago, Rock Island & Pacific, Chicago, Chairman;
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G. H. Webster, Engineer Maintenance-of-Way Manitoba & Northwestern, Winnipeg, Man.;
Samuel Rockwell, Principal Assistant Engineer Lake Shore & Michigan Southern, Cleveland, Ohio;

Committee.

1. Source of Supply:
   a Surface, method of impounding;
   b Subterranean, driven, drilled or open wells.
2. Method of Pumping and Supply:
   a Direct from tanks;
   b Through standpipes;
   c Through track tanks;
   d Cost of pumping;
   e City waterworks supplies;
   f Pumping machinery, boilers, etc.
3. Character of Water, giving analyses of good and bad water for engines; also use of compounds to counteract impurities.

XIV.—YARDS AND TERMINALS.

A. W. Sullivan, General Superintendent Illinois Central Railroad, Chicago, Chairman;
F. E. Paradis, Chief Engineer Chicago Terminal Transfer Railroad, Chicago, Vice-Chairman;
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I. G. Rawn, General Superintendent Baltimore & Ohio Southwestern Railroad, Cincinnati, Ohio;
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J. B. Cox, Chief Engineer Chicago Junction Railway, Chicago;
C. W. Hotchkiss, Chief Engineer Chicago Transfer & Clearing Co., Chicago;
C. S. Sims, Jr., Engineer Maintenance-of-Way Pennsylvania Lines, Chicago;
W. S. Kinnear, Principal Assistant Engineer Michigan Central Railroad, Detroit, Mich.;

Committee.

1. Freight Terminal Yards.
2. Passenger Terminal Yards.
3. Passing Sidings:
   a Best form of;
   b Economical length;
   c Location for passing track on double track.

4. Station Tracks:
   a Best forms; consideration as to convenience for teaming tracks, etc.);
   b Industrial tracks.
5. Gravity and Poling Yards.
6. Train Sheds:
   a Pocket sheds;
   b Through sheds;
   c Arrangement of tracks, etc.
7. "Y" tracks.

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General Manager Chicago, Peoria & St. Louis Railway,
Springfield, Ill.

MILLARD, CHARLES S.,
Engineer Maintenance-of-Way Peoria & Eastern Railway,
Indianapolis, Ind.

MODJESKI, R.,
Consulting Engineer,
1742 Monadnock Block, Chicago, Ill.

MOLITOR, F. A.,
Chief Engineer Choctaw, Oklahoma & Gulf Railroad,
Little Rock, Ark.

MOLL, J. B.,
General Roadmaster Chicago, Milwaukee & St. Paul Railway,
Old Colony Building, Chicago, Ill.

MONTFORT, R.,
Chief Engineer Louisville & Nashville Railroad,
Louisville, Ky.

MOORE, H. S.,
Resident Engineer Wabash Railroad,
Decatur, Ill.

MOORE, W. S.,
Engineer Maintenance-of-Way Cleveland, Cincinnati, Chicago & St. Louis Railway, Wabash, Ind.

MORDECAI, A.,
Assistant Chief Engineer Erie Railroad,
Cleveland, Ohio.

MORENO, C. A.,
Roadmaster Yazoo & Mississippi Valley Railroad,
Memphis, Tenn.

MORGAN, DWIGHT C.,
Engineer Maintenance-of-Way Chicago & Alton Railway,
Kansas City, Mo.

Morison, George S.,
Consulting Engineer,
35 Wall Street, New York City.

Morrison, Joseph,
Resident Engineer Central Vermont Railway,
St. Albans, Vt.

Mountain, G. A.,
Chief Engineer and Engineer Maintenance-of-Way Canada Atlantic Railway, Ottawa, Canada.

Murtaugh, B.,
Superintendent Transportation National Docks Railway,
172 Pacific Avenue, Jersey City, N. J.

N

Neff, S. S.,
Superintendent Union Elevated Railroad,
311 Fisher Building, Chicago, Ill.

Nelson, J. C.,
Division Engineer New York Central & Hudson River Railroad,
506 Grand Central Station, New York City.

Nichol, J. H.,
Assistant Engineer West Jersey & Seashore Railway,
Camden, N. J.

Nicholson, F. L.,
Engineer Maintenance-of-Way Norfolk & Southern Railroad,
Norfolk, Va.

Norton, Charles T.,
Superintendent Road Department Mexican International Railway,
Ciudad Porfirio Diaz, Mex.

O

Oborne, James,
General Superintendent Canadian Pacific Railway,
Winnipeg, Man.

P

Palmer, W. S.,
Resident Engineer Southern Pacific Company,
Oakland, Cal.

Paquette, C. A.,
Superintendent Cleveland, Cincinnati, Chicago & St. Louis Railway, Indianapolis, Ind.

Paradis, F. E.,
Chief Engineer Chicago Terminal Transfer Railroad,
Grand Central Passenger Station, Chicago, Ill.

PARKHURST, H. W.,
Engineer Bridges and Buildings Illinois Central Railroad,
Chicago, Ill.

PATTERSON, F. M.,
Assistant Roadmaster Hannibal & St. Joseph Railroad,
Brookfield, Mo.

PEDDLE, W. H.,
General Superintendent of Maintenance Southern Railway,
1300 Pennsylvania Avenue, Washington, D. C.

PENCE, WILLIAM D.,
Professor of Civil Engineering Purdue University,
Lafayette, Ind.

PETERSON, P. A., (First Vice-President),
Chief Engineer Canadian Pacific Railway,
Montreal, Canada.

PFAFFLIN, E. H.,
Chief Engineer Evansville & Terre Haute Railroad,
Evansville, Ind.

PHILBRICK, ALVAH,
Superintendent Illinois Central Railroad,
Memphis, Tenn.

PIERCE, H.,
Engineer Maintenance-of-Way Chesapeake & Ohio Railway,
Huntington, W. Va.

POLAND, WILLIAM B.,
Division Engineer Baltimore & Ohio Southwestern Railroad,
Washington, Ind.

PROUT, H. G.,
Chief Editor "Railroad Gazette,"
32 Park Place, New York, N. Y.

PURCELL, THOMAS,
Division Superintendent Mexican National Railroad,
Matamoros, Mex.

Q

QUINLAN, G. A.,
Vice-President and General Manager Houston & Texas Central
Railroad, Houston, Texas.

R

RAWN, I. G.,
General Superintendent Baltimore & Ohio Southwestern Railroad,
Cincinnati, Ohio.

RAYMER, A. R.,
Assistant Engineer Pittsburg & Lake Erie Railroad,
Pittsburg, Pa.

RICHARDS, J. T.,
Engineer Maintenance-of-Way Pennsylvania Railroad,
Philadelphia, Pa.

RICHARDS, O. D.,
Chief Engineer Ann Arbor Railroad,
Toledo, Ohio.

ROBINSON, H. P.,
Editor "Railway Age,"
Chicago, Ill.

ROBINSON, J. B.,
Resident Engineer Southern Pacific Company,
Sacramento, Cal.

ROCKWELL, SAMUEL,
Principal Assistant Engineer Lake Shore & Michigan Southern Railway, Cleveland, Ohio.

RODD, THOMAS, (Director),
Chief Engineer Pennsylvania Lines West,
Pittsburg, Pa.

RODGERS, J. G.,
Superintendent New York, Philadelphia & Norfolk Railroad,
Cape Charles, Va.

ROGERS, M. H.,
Chief Engineer Denver & Rio Grande Railroad,
Denver, Colo.

ROHWER, HENRY,
Assistant Engineer Missouri Pacific Railway,
Sedalia, Mo.

S

SABIN, A. T.,
Assistant Engineer Illinois Central Railroad,
Covington, Tenn.

SAFFORD, H. R.,
Roadmaster Illinois Central Railroad,
Clinton, Ill.

SANDERS, E. B.,
Assistant Engineer Southern Railway,
1300 Pennsylvania Avenue, Washington, D. C.

SANFORD, A. H.,
Engineer Maintenance-of-Way Pennsylvania Lines West,
Toledo, Ohio.

SCARBOROUGH, F. W.,
Engineer Bridges and Signals Chesapeake & Ohio Railway,
Richmond, Va.

SCHINDLER, A. D.,
Division Superintendent San Francisco & San Joaquin Valley Railway, Stockton, Cal.

SCHMIDT, H. W.,
Chief Engineer and Superintendent Centralia & Chester Railroad,
Sparta, Ill.

SHAW, LOUIS,
Civil Engineer U. S. Government,
La Crosse, Wis.

SHEAHAN, DENNIS,
Roadmaster Illinois Central Railroad,
Memphis, Tenn.

SHELAH, EDWARD,
General Roadmaster Wabash Railroad,
Decatur, Ill.

SHEPARD, W.,
Chief Engineer Boston & Albany Railroad,
Boston, Mass.

SHOBER, S. L., Jr.,
Assistant Engineer Pennsylvania Railroad,
Tyrone, Pa.

SIMS, C. S., Jr.,
Engineer Maintenance-of-Way Pennsylvania Lines West,
Chicago, Ill.

SLIFER, H. J.,
Superintendent Chicago & North-Western Railway,
Boone, Iowa.

SLOAN, DAVID,
Chief Engineer Illinois Central Railroad,
Chicago, Ill.

SOUTHGATE, R.,
Superintendent Track, Bridges and Buildings Southern Railway,
Charlotte, N. C.

SPOUFE, C. C.,
Resident Engineer Southern Pacific Company,
Tucson, Ariz.

STEINBECK, E. J.,
Roadmaster Illinois Central Railroad,
Freeport, Ill.

STEVENS, F. S.,
Division Engineer Philadelphia & Reading Railway,
Reading, Pa.

STOREY, W. B., Jr.,
Engineer and General Superintendent San Francisco & San Joaquin Valley Railway, San Francisco, Cal.

SULLIVAN, A. W.,
General Superintendent Illinois Central Railroad, Chicago, Ill.

SWAINE, E. L.,
Resident Engineer Southern Pacific Company, Los Angeles, Cal.

T

TAIT, THOMAS,
Manager Eastern Lines, Canadian Pacific Railway, Montreal, Can.

TAYLOR, J. W.,
Chief Engineer Terminal Railroad Assn., and Merchants' Bridge Ter. Railway, St. Louis, Mo.

THOMAS, J. W., Jr.,
General Manager Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

THOMPSON, BENJAMIN,
Resident Engineer Southern Railway, Greensboro, N. C.

TORREY, A., (Director),
Chief Engineer Michigan Central Railroad, Detroit, Mich.

TRATMAN, E. E. RUSSELL,
Resident Editor "Engineering News," Monadnock Block, Chicago, Ill.

TRIMBLE, ROBERT,
Principal Assistant Engineer Pennsylvania Lines West, Pittsburg, Pa.

TWEEDY, R. B.,
Chief Engineer Wisconsin Central Lines, Milwaukee, Wis.

U

UNDERWOOD, F. D.,
Second Vice-President and General Manager Baltimore & Ohio Railroad, Baltimore, Md.

V

VAN VLECK, W. G.,
General Manager Atlantic System Southern Pacific Company, Houston, Texas.

VAUGHAN, G. W.,
Supervisor Bridges and Buildings New York Central & Hudson River Railroad, New York City.

VAUGHN, G. W.,
Engineer in Charge of Joint Track Elevation Atchison, Topeka & Santa Fe Railway and Chicago, Minneapolis & Northern, 405 East Twenty-second Street, Chicago, Ill.

W

WALLACE, J. F., (President),
Assistant Second Vice-President Illinois Central Railroad, Chicago, Ill.

WALLACE, H. U.,
Superintendent Illinois Central Railroad, Freeport, Ill.

WALLACE, J. H.,
Assistant Engineer Maintenance-of-Way Southern Pacific Company, San Francisco, Cal.

WALKER, I. O.,
Division Engineer Nashville, Chattanooga & St. Louis Railway, Paducah, Ky.

WASHINGTON, L. A.,
Assistant Engineer Illinois Central Railroad, Paducah, Ky.

WEBSTER, G. H.,
Engineer Maintenance-of-Way Manitoba & Northwestern Railway, Winnipeg, Man.

WENDT, E. F.,
Assistant Engineer Pittsburg & Lake Erie Railroad, Pittsburg, Pa.

WHEATON, L. H.,
General Superintendent and Chief Engineer Central Railway of Nova Scotia, Yarmouth, N. S.

WHITE, H. F.,
Chief Engineer Burlington, Cedar Rapids & Northern Railway, Cedar Rapids, Iowa.

WHITE, I. F.,
Superintendent Track and Structures Cincinnati, Hamilton & Dayton Railway, Hamilton, Ohio.

WHITTELSEY, T. F.,
General Superintendent Toledo & Ohio Central Railway,
Toledo, Ohio.

WHITTEMORE, D. J., (Director),
Chief Engineer Chicago, Milwaukee & St. Paul Railway,
Chicago, Ill.

WICKHAM, C. E.,
Division Engineer Chicago, Rock Island & Pacific Railway,
Chicago, Ill.

WILGUS, W. J.,
Chief Engineer New York Central & Hudson River Railroad,
New York City.

WILLARD, DANIEL,
Assistant General Manager Baltimore & Ohio Railroad,
Baltimore, Md.

WILLIAMS, H. R.,
General Superintendent Chicago, Milwaukee & St. Paul Railway,
Chicago, Ill.

WILLIAMS, W. D.,
Chief Engineer, Cincinnati Northern Railroad,
Van Wert, Ohio.

WILSON, C. A.,
Chief Engineer Cincinnati, Hamilton & Dayton Railway,
Cincinnati, Ohio.

WILSON, J. T.,
Chief Engineer Pittsburg, Connellsville & Wheeling Railroad,
Moundsville, W. Va.

WOODS, H. A.,
Assistant Engineer Chicago & Grand Trunk Railway,
Detroit, Mich.

WOODWARD, E. K.,
Engineer Maintenance-of-Way Wabash Railroad,
Detroit, Mich.

WOODWORTH, G. B.,
Rail Inspector Chicago, Milwaukee & St. Paul Railway,
Old Colony Building, Chicago, Ill.

Z

ZIESING, A.,
Consulting Engineer,
1324 Monadnock Block, Chicago, Ill.

In Memoriam

CLARENCE ALLEN CARPENTER,

Division Engineer Lake Shore & Michigan Southern.

Died November 11, 1899, aged 53 years.

Mr. Carpenter entered the railway service in 1863, taking service with the Adirondack road as rodman. In 1869 he became Assistant Engineer of the Missouri, Kansas & Texas Railway; from 1870 to 1871 he was with the Little Rock & Fort Smith Railway as Assistant Engineer, and from 1871 to 1876 Resident Engineer of the New York & Canada road. During the years 1877-78 he was engaged as Resident Engineer in New York State work; from 1878 to 1880 he was employed on the Central branch of the Union Pacific as Assistant Engineer, and occupied the same position with the Chicago, Milwaukee & St. Paul road for six years, and one year as Division Engineer same road; from the year 1887 he was with the Kansas City line as Division Engineer of Construction and also as Principal Assistant Engineer of the Bridge Department; for a portion of the year 1891 he was with the Northern Pacific in the capacity of Engineer, when he was appointed Division Engineer of the Lake Shore & Michigan Southern, continuing in this position up to the time of his demise.

FERDINAND HALL,

Chief Engineer Chicago, Indianapolis & Louisville.

Died November 22, 1899, aged 44 years.

Mr. Hall's first railway service was with the Burlington & Ohio River Railroad in 1882, and in the same year was appointed Assistant Engineer of the Chicago & Alton Railroad, with which road he remained until 1887, when he received the appointment of Chief Engineer of the Louisville, New Albany & Chicago Railroad, now known as the Chicago, Indianapolis & Louisville Railroad, which place he held until his death.

In Memoriam

RICHARD CAFFREY,

General Inspector of Track Lehigh Valley Railroad.

Died September 26, 1899, aged 62 years.

Mr. Richard Caffrey was born in Ireland, in 1837, and came to this country in 1846, locating in Easton, Pa. He entered the service of the Lehigh Valley Railroad when it was being constructed, and served as foreman from the time it was completed until 1864, when he was made Roadmaster of the Penn Haven and White Haven divisions. When a change was made in the designation of the divisions, in 1874, he was made Roadmaster of the newly-made Lehigh & Wyoming divisions, with supervision over 284 miles of track, and served in this capacity until 1885, when the New Jersey division was added to his territory, increasing the length of lines under his care to 392 miles. In 1890 he was promoted to the office of General Roadmaster of all the Lehigh Valley lines, and in 1896 was made Engineer Maintenance-of-Way, which position he held until the retirement of the Chief Engineer in 1898, when the latter office was abolished, and the duties devolving on the Engineer Maintenance-of-Way, Mr. Caffrey was made General Inspector of Track, with practically the same duties as heretofore. This position he held until his death, which occurred September 26, 1899. He was not a civil engineer, but a thoroughly practical Maintenance-of-Way officer, and enjoyed to the utmost the confidence of his superior officers. He was at one time President of the Roadmasters' Association of America, and at all times one of its most active members.

JOHN CHARLES O'MELVENY,

Chief Engineer Oregon Short Line Railroad.

Died October 3, 1899, aged 39 years.

Mr. O'Melveny entered the railroad service with the Ohio & Mississippi Railway in 1880, and in 1882 was made Assistant Engineer of the same road. During the year 1883 he was engaged in location and railway surveys in Kentucky and Illinois, and from 1883 to 1885 was employed on the preliminary Chicago line of the Santa Fe road. From 1886 to 1897 he was with the Union Pacific as Assistant Engineer in charge of various railroad and bridge work, and from 1897 to the time of his death was Chief Engineer of the Oregon Short Line.

Summary of Circulars Issued.

CIRCULAR NO. 1.

To Railway Engineers and Maintenance-of-Way Officials:

A preliminary meeting for the purpose of organizing a Railway Engineering and Maintenance-of-Way Association was held in Chicago, October 21, 1898, pursuant to call issued by the "Railway Age."

About twenty officials of various railways responded in person, and upwards of one hundred sent communications, approving the movement, and expressing desire to be identified with the organization.

Mr. H. P. Robinson, President of "The Railway Age," Chicago, called the meeting to order, explained its purpose, rendered valuable aid in the initiatory proceedings, and submitted important data as a basis of organization.

Mr. Augustus Torrey, Chief Engineer of the Michigan Central Railroad, Detroit, Mich., was chosen Chairman.

Mr. L. C. Fritch, Superintendent of the Baltimore & Ohio Southwestern Railroad, Washington, Ind., was selected as Secretary.

A committee, appointed by the Chairman, recommended that the Association be entitled "THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION." A resolution was passed, adopting this name for the Association.

The Chairman was directed to appoint a committee, consisting of five representative Railway Engineers or Maintenance-of-Way Officials of America, to draft a Constitution and By-Laws, reporting at the next meeting.

The Secretary was directed to communicate with the Railway Engineers and Maintenance-of-Way Officials of America on questions of organization of the Association.

The Chairman was directed to call the next meeting of the Association, to be held at Buffalo, N. Y., early in March, 1899.

CIRCULAR NO. 2.

March 20, 1899.

To American Railway Engineering and Maintenance-of-Way Officials:

A meeting of this Association, for the purpose of adopting a Constitution and perfecting a permanent organization, will be held at the Iroquois Hotel, in Buffalo, N. Y., on Thursday, March 30, 1899, at 10 o'clock a. m.

All officials of American railways interested in the operation, construction or maintenance of railroads are requested to be present at this meeting.

The report of the Committee on Constitution and By-Laws will be submitted at this meeting.

All persons contemplating attendance will please notify the Secretary as early as possible, in order that provision may be made for accommodations.

CIRCULAR NO. 3.

March 31, 1899.

The American Railway Engineering and Maintenance-of-Way Association perfected its permanent organization at a meeting held at Buffalo, N. Y., March 30, 1899.

The Constitution prepared by the Committee was adopted, the charter membership applications passed upon by the Organization Committee, and the following officers were elected:

President—J. F. Wallace, Illinois Central Railroad, Chicago, Ill.

First Vice-President—P. A. Peterson, Canadian Pacific Railway, Montreal, Can.

Second Vice-President—W. G. Curtis, Southern Pacific Railway, San Francisco, Cal.

Secretary—L. C. Fritch, Baltimore & Ohio Southwestern Railroad, Washington, Ind.

Treasurer—W. S. Dawley, Chicago & Eastern Illinois, Chicago, Ill.

DIRECTORS.

For three years:

A. Torrey, Michigan Central Railroad, Detroit, Mich.

Thos. Rodd, Pennsylvania Lines West of Pittsburg, Pittsburg, Pa.

For two years:

D. J. Whittemore, Chicago, Milwaukee & St. Paul, Chicago, Ill.

F. H. McGuigan, Grand Trunk Railway, Montreal, Can.

For one year:

W. K. McFarlin, Delaware, Lackawanna & Western, Hoboken, N. J.

Hunter McDonald, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

CIRCULAR NO. 4.

May 15, 1899.

To Charter Members:

At a meeting of the Board of Direction, held in Chicago, May 12, 1899, an outline of committee-work was submitted, embracing fourteen general subjects, it being proposed to form a standing committee for each general subject.

This outline is herewith submitted for the careful consideration of the members of the Association and others interested. Any suggestions as to additions or modifications are especially invited, to be transmitted to the Secretary before July 1, 1899.

It is also requested that members suggest or designate the names of persons, either members or persons who may become members, that would make suitable or appropriate chairmen or committeemen of the various committees, it being the earnest desire of the Board of Direction that the personnel of the various committees may be based upon the adaptability and fitness of the members composing each particular committee, in order that the best results may be obtained in the work of these committees.

CIRCULAR NO. 5.

Chicago, Ill., November 30, 1899.

To Officers and Managers of American Railways:

The American Railway Engineering and Maintenance-of-Way Association was formally organized March 30, 1899.

The object of the Association is "the advancement of knowlege pertaining to the scientific and economical location, construction, operation and maintenance of railroads."

The membership of the Association may include "any railroad official who is responsible for or has supervision of maintenance-of-way matters, embracing all grades of officials from general managers to engineers of maintenance-of-way in charge of divisions, inclusive, or officials of other titles with similar duties."

The organization is only eight months old and has already attained a membership representing over 140,000 miles of railways and 104 distinct railway companies, embracing lines in United States, Canada and Mexico, some of the individual companies having a membership of twenty-five members.

The work outlined by the Association is on broad and comprehensive lines, and already fourteen standing committees have been chosen to investigate and report upon eighty distinct subjects applicable to the purpose of the Association.

It will be the duty of these committees to make thorough investigation and research into the present practices on the different railways of the country, after which the information will be classified and arranged. From these data certain conclusions and results will be obtained and the recommendations of the committees on the various subjects embodied in the form of reports, which, after discussion by the Association, will be published.

It will be seen, therefore, that the results to be obtained from this method cannot fail to be of vast benefit in attaining a degree of perfection in the economical operation of the Maintenance-of-Way Department that will be invaluable to American railway operation.

The work of the Association is receiving the hearty approval and encouragement of the managements of some of the largest railway systems.

The "Maintenance-of-Way Association" hopes to accomplish for the Maintenance-of-Way Department what the Master Car Builders' and the American Railway Associations are accomplishing for the Maintenance of Equipment and Transportation Departments, and its success will be largely increased by a membership which will include every important railway line in America.

CIRCULAR NO. 6.

Chicago, February 21, 1900.

To Members of the Association:

The annual election of officers of the American Railway Engineering and Maintenance-of-Way Association will be held at the first annual meeting, in Chicago, March 14, 1900.

On account of the Association being practically in process of formation, the Nominating Committee has considered it to be for the best interests of the Association to renominate the officers whose terms will expire, and request them to serve another year.

For the same reason it was deemed expedient to continue those members of the Board of Direction, whose terms expire at this time, for another year—thus, one Vice-President and two Directors, to serve one year; one Vice-President and two Directors, whose terms would expire a year hence, to serve for two years; two Directors, whose terms expire in two years, to serve three years.

Members desiring to cast their votes for others than those submitted by the Nominating Committee will please do so on the blank space under each name on the ballot.

[Circular No. 7—Establishing Headquarters in Chicago.]

CIRCULAR NO. 8.

Chicago, March 3, 1900.

To Chairmen of Committees:

At the annual meeting in March it is the intention to handle the reports of the general standing committees in the following manner:

Each chairman is expected to present a brief, concise paper, outlining the subject-matter to be considered by his committee, and the manner in which the committee-work shall be carried on. It is desired that each chairman shall organize his committee prior to the opening of the convention, and that during the reading and discussion of his paper he shall have his committee seated in the front body of the room, seated at the right of the Chairman; each chairman should read his own report, or, in his absence, the vice-chairman, and if both should be absent, some other member of the committee; it is then expected that this report shall be thrown open for general discussion by the members of the Association at large, and the chairman or members of the committee are expected to answer any questions that may be asked in relation to the report or the work of the committee.

It is desired that these reports serve as a preface or introduction to the consideration which in years to come may be given to the subject-matter, and that the substance of the various reports and the method

of handling the work of each committee shall be fully and freely discussed by the general membership of the Association, in order that the various chairmen, their committees and the general members may be fully advised of how each committee's work is to be carried on.

You will, of course, note from the printed outline of committee-work that the scheme is a comprehensive one, and that it will provide plenty of work for the various committees and the Association at large during the lifetime of the present members at least. It is not intended to exhaust the subject-matter of any committee in one year, or even within the lifetime of the members. The idea is to provide a basis for a thorough, scientific and systematic investigation of all matters connected with the objects of the Association, a field of research and consideration which is practically inexhaustible.

If the chairmen of the various committees have not already done so, they will please at once advise the Secretary of their purpose to be present at the annual meeting, and at the same time (or as soon as they can get their reports ready) send a copy of same to the Secretary, so he can have it printed and ready for use at the meeting. If, for any reason, the chairman of any committee cannot be present, he will please call on his vice-chairman to attend and read the report of his committee; and if the vice-chairman should also be unable to attend, arrange with some other member of the committee to be present and read the report.

Chairmen of committees are requested to call meetings and organize their committees prior to the opening of the convention, and arrange for frequent meetings of their committees between the sessions of the main body of the Association, or at such other times as may be convenient, so as to maintain their organization throughout the period of the convention.

STATEMENT SHOWING THE MILEAGE OF THE ROADS REPRESENTED BY MEMBERS OF THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION.

Name of Road.	Mileage.	No. of Members.
Algoma Central Railway	60	1
Ann Arbor Railroad	292	1
Arkansas Northern Railway	125	1
Atchison, Topeka & Santa Fe Railway	6,094	2
Baltimore & Ohio Railroad	2,048	5
Baltimore & Ohio Southwestern Railroad	933	5
Boston & Albany Railroad	394	1
Buffalo & Susquehanna Railroad	162	1
Buffalo, Rochester & Pittsburg Railway	338	1
Burlington, Cedar Rapids & Northern Railway	1,136	2
Canada Atlantic Railway	448	1
Canadian Pacific Railway.	7,684	5
Centralia & Chester Railroad	100	1
Central New England Railway	181	1
Central Railway of Nova Scotia	74	1
Central Vermont Railway	511	2
Chesapeake & Ohio Railway	1,465	2
Chicago & Alton Railway	902	6
Chicago & Eastern Illinois Railroad	710	3
Chicago & North-Western Railway	6,676	3
Chicago & Western Indiana Railroad	55	1
Chicago, Burlington & Quincy Railroad	6,231	3
Chicago Great Western Railway	932	1
Chicago Junction Railway	297	1
Chicago, Milwaukee & St. Paul Railway	6,382	5
Chicago, Peoria & St. Louis Railroad	282	1
Chicago, Rock Island & Pacific Railway	3,619	2
Chicago Terminal Transfer Railroad	214	4
Chicago Transfer & Clearing Company	100	1
Choctaw, Oklahoma & Gulf Railroad	563	1
Cincinnati, Hamilton & Dayton Railway	653	2
Cincinnati Northern Railroad	415	1
Cleveland, Akron & Columbus Railway	219	1
Cleveland, Cincinnati, Chicago & St. Louis Railway	2,345	6
Cleveland, Lorain & Wheeling Railway	196	1
Copper Range Railroad	40	1
Delaware, Lackawanna & Western Railroad	920	1

Name of Road.	Mileage.	No. of Members.
Denver & Rio Grande Railroad	1,673	2
Detroit & Mackinac Railway	314	1
Duluth & Iron Range Railroad	185	1
Erie Railroad	2,271	2
Esquimalt & Nanaimo Railway	80	1
Evansville & Terre Haute Railroad	317	1
Federal District Railway of Mexico	220	1
Fitchburg Railroad	458	2
Florence & Cripple Creek Railroad	43	1
Florida Central & Peninsular Railroad	942	1
Fremont, Elkhorn & Missouri Valley Railroad	1,363	1
Grand Trunk Railway	4,186	4
Great Northern Railway	4,094	1
Gulf, Colorado & Santa Fe Railway	1,128	3
Hocking Valley Railway	346	1
Houston & Texas Central Railroad	565	2
Houston East & West Texas Railway	232	1
Illinois Central Railroad	3,996	30
Iowa Central Railway	533	1
Kansas City, Fort Scott & Memphis Railroad	1,243	2
Lake Shore & Michigan Southern Railway	1,413	3
Lehigh Valley Railroad	1,393	1
Long Island Railroad	409	2
Louisville & Nashville Railroad	3,158	2
Manitoba & Northwestern Railway	250	1
Mexican Central Railway	2,012	1
Mexican International Railway	731	1
Mexican National Construction Company	89	1
Mexican National Railroad	1,266	1
Michigan Central Railroad	1,679	5
Minneapolis & St. Louis Railroad	602	1
Missouri, Kansas & Texas Railway	2,208	1
Missouri-Pacific Railway	5,394	1
Mobile & Ohio Railroad	687	1
Montana Railroad	100	1
Nashville, Chattanooga & St. Louis Railway	1,189	4
National Docks Railway	23	1
Nevada County Narrow-Gauge Railroad	23	1
New York Central & Hudson River Railroad	6,295	5
New York, Chicago & St. Louis Railroad	533	2
New York, New Haven & Hartford Railroad	2,047	1
New York, Philadelphia & Norfolk Railroad	112	1
Norfolk & Southern Railroad	104	1
Norfolk & Western Railway	1,551	1
Northern Pacific Railway	4,887	1
Ocos Railway	30	1

Name of Road.	Mileage.	No. of Members.
Ohio River Railroad	269	2
Pennsylvania Lines West of Pittsburg	4,657	9
Pennsylvania Railroad	3,726	4
Peoria & Eastern Railway	350	1
Pere Marquette Railroad	1,884	2
Philadelphia & Reading Railway	1,114	3
Pittsburg & Lake Erie Railroad	180	4
Pittsburg & Western Railway	343	1
Pittsburg, Connellsville & Western Railway	100	1
St. Louis & San Francisco Railroad	1,642	1
San Francisco & San Joaquin Valley Railway	304	2
Santa Fe, Prescott & Phoenix Railway	224	1
Seaboard Air Line	961	1
South Haven & Eastern Railroad	100	1
Southern Pacific Company	7,411	19
Southern Railway	6,064	8
Terminal Railroad Association of St. Louis	18	1
Terre Haute & Indianapolis Railroad	430	1
Terre Haute & Logansport Railway	182	1
Toledo & Ohio Central Railway	543	1
Union Elevated Railroad of Chicago	10	1
Union Pacific Railroad	2,848	2
Vera Cruz & Pacific Railroad	85	2
Wabash Railroad	2,321	3
Waycross Air Line	70	1
Western New York & Pennsylvania Railway	633	2
Wheeling & Lake Erie Railroad	415	1
Wisconsin & Michigan Railway	72	1
Wisconsin Central Lines	1,004	2
Yazoo & Mississippi Valley Railroad	1,006	3
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PROCEEDINGS

OF THE

SECOND ANNUAL CONVENTION

OF THE

American Railway Engineering and Maintenance-of-Way Association

HELD AT

AUDITORIUM HOTEL, CHICAGO, ILLINOIS

MARCH 12, 13 AND 14, 1901

VOLUME 2

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ON PUBLICATIONS

1901

J. F. WALLACE, PRESIDENT.

L. C. FRITCH. SECRETARY.

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PROCEEDINGS

TUESDAY, MARCH 12, 1901.

The meeting was called to order at 10 a. m. by the President, Mr. J. F. Wallace.

The President:—Our order of procedure will be practically the same as last year. The first thing in order is the reading of the minutes of the last meeting. As those minutes have already been printed and are in the hands of the members, if there is no objection, we will consider them adopted. Are there any objections? There are none; the minutes stand approved.

The next in order is the report of the Secretary and Treasurer. Mr. Fritch, the Secretary, has the reports of both the Treasurer and himself, which he will now read:

REPORTS OF THE TREASURER AND SECRETARY.

Total receipts from all sources from organization to March 11, 1901	$6,909 85
Total expenses from organization to March 1, 1901	4,792 35
Net cash surplus on hand	$2,117 50
Arrears for fees and dues to January 1, 1901	$1,260 00
Total assets	$3,377 50

MEMBERSHIP.

Total number of members enrolled since organization to date		375
Deceased members	9	
Resignations	7	
	16	16
Total membership to date		359
Membership at last annual meeting		235
Members admitted during the year		124
Total		359

Representing 172,183 miles of railways.

DECEASED MEMBERS.

Since the last annual meeting, the Association has lost by death the following members:

W. G. CURTIS, Second Vice-President of the Association;
D. J. CASEY, S. E. BURKE,
L. H. CLARKE, H. W. SCHMIDT.

The President:—You have heard the report. As it is simply a summary and abstract of the report which has already been made to the Board of Direction, and is supervised and passed upon by the Board, who are responsible for these expenditures, I believe it needs no action on the part of the Association, but is simply read for your information.

You will note that in spite of the large number of delinquents, we have cash on hand, and that your Board have run this Association on business principles. The reason we have a surplus is due to the fact that we have not spent any money until it was in the treasury, and the scope of our expenditures and what we will be able to give you in the way of publications, etc., in the future will depend on our receipts and our finances. The more money we take in, the more liberal we expect to be in our expenditures, and if the present policy of the Board of Direction is continued in the future, we will always endeavor to keep you out of debt.

Under the Constitution, the President is required to give an address. This is too dignified a name to apply to the few remarks I desire to make.

PRESIDENT'S ADDRESS.

At the close of the second year of the life of this Association the members have every reason to congratulate themselves on the results so far achieved. The Secretary's report shows that the Association is now an accomplished fact. The mileage represented, the character of its membership, and the enthusiasm with which the work has been undertaken, assure a prosperous future. The progress so far made certainly justifies the Association's existence. While the problems which it has undertaken to solve are large ones, the manner in which the Association has commenced its work is a guarantee that in working out or at a solution of these problems much benefit will accrue to the railroads represented in this organization, as well as to the individual members.

The hand-to-mouth method of managing railroads, particularly as applied to maintenance problems, is rapidly passing into disuse, and more

consideration is being given year by year to the true economy of maintenance. In the ideal maintenance of any railroad property, the sums expended should not vary materially from year to year; the different classes of renewals should be made systematically and regularly, regardless of temporary fluctuations in earnings. The closer the management can get to regularity in its maintenance expenses, the more economical results will be obtained. The railroad situation in this country is rapidly approaching a condition of permanency, and as owners and managers can predict from past records with reasonable accuracy their probable revenues, they should be able to closely estimate the sums required for future maintenance.

When the Chief Engineer, General Superintendent, or whatever officer has charge of the physical condition of the property, can lay before his General Manager carefully prepared and accurate budgets of expenses for the year, as well as estimates of the normal amounts that should be spent on the different items, the haphazard methods of management in this respect will rapidly disappear, and the work will be intelligently and satisfactorily handled to owner, manager and engineer. The worry of explaining why the expenditures in any certain month or on account of any one item were more than in the previous year will cease.

While there are some items, like renewals of steel bridges, rail, station buildings, etc., which cannot well be provided for with regular annual appropriations for renewals, the average amounts necessary for these renewals can be determined with approximate accuracy; and certain sums could be charged out and set aside to cover these extraordinary renewals. The minor items, such as renewals of wooden bridges or their replacement by more permanent structures, the widening of excavations, strengthening of embankments, renewal of ballast and ties, minor repairs to buildings and structures, fencing, and the many items that enter into the repairs of road account, should, however, be approximately determined and the amounts expended therefor made uniform.

When the work is laid out and carried forward on some such basis, comparative statements will then be of more value, and the fluctuations above or below normal will be due to causes which can be determined and explained, and the comparative efficiency of different men in the economical handling of road department matters more reliably observed.

In connection with this, I want to call attention to something we have all had experience with. We all know of instances where railroads have been in charge of engineers who work hard and faithfully to put the property in proper condition, and we have seen that management criticised for extravagance; and we have seen this management followed by some person who was supposed to be a practical man, who would cut expenses down to the core and make a reputation on what his predecessor had done. On the other hand, we have seen men put in charge of property who have had to spend large sums of money in order to make good the deficit, and the amounts that had practically been cut in two in order to make some other person's reputation. To do away with conditions

such as I have just described requires method in apportioning the money and provide for these expenditures.

One of the questions which our various committees should determine by the collection of facts from the experience of different roads and the sums expended by them on the different items of maintenance, is the approximate normal amounts necessary for the proper maintenance of railroad properties. It is, of course, true that we should not be misled by averages, as conditions vary on the different roads, due to physical, climatic or traffic characteristics; but the consideration of this question along these lines will be beneficial and educational, and will very materially help both the officers having direct control of maintenance-of-way expenditures and the managements.

In these remarks attention has only been called to the fundamental principles and the general lines along which this important subject of economical railroad maintenance should be approached. Above all things, we should give consideration to the proper relation of things, and not fall into the error which many engineers make of looking at this question from a technical standpoint only, and endeavor to rear the most substantial and perfect monuments to their own skill—building structures to which they can point with pride as samples of their work, and losing sight of the fact that the ultimate aim of railroad construction and maintenance is to provide for the safe, expeditious, and economical handling of traffic. To this end all other considerations are subordinate.

In retiring from the chair, I desire to thank the officers and members for the invariably kind treatment I have received at their hands, and for their hearty and enthusiastic support through what will undoubtedly prove to have been the two most trying years in the existence of the Association. I shall always retain the liveliest interest in your work, and shall continue to aid it at every opportunity. Though severing my official connection with the Association, I will watch its progress with the closest interest, and feel confident that the new officers will carry on the work with even better results than have been achieved in the past. [Applause.]

The President:—The Secretary has some announcements to make, if you will kindly listen to them.

The Secretary:—The Illinois Central Railroad Company have tendered the members of the Association and their friends a special train, which will leave the Van Buren Street depot at 1:10 p. m., on Wednesday, March 13, for the Illinois Steel Company's plant at South Chicago, and the Illinois Steel Company's representatives will conduct the party through the plant. Luncheon will be served on the train after leaving Van Buren Street station. Members desiring to avail themselves of this trip are requested to advise the Secretary. Tickets for the banquet to be held at the Auditorium Hotel on the evening of March 13 can

be had in the anteroom of the convention hall by applying to the assistant in charge of the sale of tickets.

The Technical Club of Chicago invites the members of the Association and their friends—the ladies are also invited—to a reception to be held at the Technical Club's rooms, No. 230 Clark Street, on Tuesday evening, at 7 o'clock. The Technical Club has also extended to the members of the Association the privileges of the Club while the members are in the city.

The President:—The next in order is reports of standing committees. During the discussion of the reports members taking part will please announce their name and the name of the road with which they are connected, on addressing the Chairman, so that the reporters can get them correctly.

The reports of committees have been printed and distributed among the members; it has therefore been decided not to read these reports, in order to save time, in view of the large amount of work we have to do this morning.

The Committee on Graduation is first. Mr. McNab and his Committee will please come forward. The Secretary will read their names.

REPORT OF COMMITTEE ON GRADUATION.

To the American Railway Engineering and Maintenance-of-Way Association:

The term Graduation as here used, is intended to embrace the preparation of the ground, the excavation and placing of the material, and other general work incident to the formation and maintenance of the railway roadbed and yards.

It is therefore the fundamental element in construction, and upon the design adopted for the cross-section of the roadway and its accessories, and the manner of placing in the embankment the several kinds of material from excavation, will depend largely the future cost of maintenance.

Innumerable instances are noticeable in which much expenditure after construction might have been avoided or minimized, if false economy had not been originally practiced, by making insufficient width at sub-grade, and giving too steep a pitch to the slopes of the cuts and fills; as well as by the neglect of drainage features, requiring ultimately substantial rectification.

In the extent of territory embraced by the lines having representation in this Association, every physical, climatic, and commercial condition and influence exists, and therefore no plan or dimensioned section can be taken as standard that will absolutely apply to all. In regard, however, to the

shape, dimensions, and other features connected with the roadbed, and matters generally incident to the slopes, drainage, and maintenance of embankments and cuttings, it has been the aim of the Committee to keep in view the broad lines of good theory, and the best practice, recognizing that if these be rightly understood, ordinary details which may vary in individual instances, according to locality and special surroundings, can be accommodated to them.

The Committee has made an analysis of the drawings and specifications of representative railways in all parts of the country, and the fact intimated in last year's report that great dissimilarity exists in standards, even under similar general conditions, is much emphasized by this analysis.

Some roads use no general standards in regard to cross-sections, or have standards which exist only on paper; others have plans which have been in use thirty or forty years without revision to meet modern requirements of loads and speed, and are time-honored. Some have standard sections, the general principles of which are the same as those used by a larger system, but which have been slightly altered without apparent reason—and frequently to the disadvantage of the road making the change; others have admirable plans, with ideas carefully thought out, but which leave room even yet for modification or amplification, whilst still others have plans in which the cost of the work represented is beyond the financial resources of ordinary roads.

After this analysis, the Committee is of the opinion that in many instances a needless refinement is exhibited in regard to the shape of the roadbed at sub-grade, viz., a curve, series of curves, or a series of planes at various angles, shapes which are not easy to make and maintain, and are rarely adhered to in actual practice. Simple drainage planes of a uniform slope of .04 per foot falling from each side of the centre line of roadway are easy to make, and are found to be effective.

The width of roadbed is also, generally speaking, too narrow—twenty feet on embankments, and a corresponding width between ditches in cuts should be taken as minimum for single track, on what may be termed a first-class road, with an addition of thirteen to fourteen feet in case of double track.

The surface ditches in cuts should be kept well below the intersections of the sub-grade planes with the planes of the slopes of the cut, and the shape such, as can most economically be maintained. Surface ditches on curved portions of the road should be on the same level, the inclination of the track being made up in the ballast.

In order to benefit railways generally, and more especially the smaller lines, or those with limited means, it is the intention of the Committee in a future report, to submit sketches of roadbed with its several accessories, that might be taken as a standard for a first-class road, and at the same time show how such can best be modified to suit these smaller lines.

On preliminary and location profiles, the several descriptions, or the nomenclature indicating the classes of material or the kinds of ground, are frequently imperfect or misleading for the proper determining of the most

suitable slopes, and the best methods of dealing with unstable ground upon which embankments are to be constructed. The engineer of location should therefore not only possess a thorough practical knowledge of the condition and physical composition of every class of soil and rock met with, but be precise in recording it.

To ensure substantial embankments, much depends upon four important features: first,—proper clearing and grubbing of the ground to receive the earthwork; secondly,—that the nature of the ground is either suitable for supporting the fill which is to overlie it, or can be made so by drainage or otherwise; thirdly,—placing of excavated material in the most suitable locations with regard to greatest frictional resistance in masses; fourthly,—trimming to the slope adopted.

In embankments of two feet or less in height, the whole of the space occupied should be thoroughly grubbed out, and where they are more than two feet, and less than four feet, all trees and stumps should be cut at least two feet below sub-grade.

In preparing unstable ground for the embankment, it should be subjected to the closest examination as to its nature, with a view to remedy before placing material upon it. Preliminary drainage is frequently all that is necessary. If the land is swampy, with a thin crust of insufficient strength for the weight to be supported (commonly called a "sink hole") it may be necessary to continue filling in material until a solid foundation is obtained, in order to secure a roadbed that can be used with undiminished speed, but there are numerous other methods, each depending on local conditions.

If the swampy material be on a side hill, it should first be drained by means of a side ditch on the upper side, parallel to the roadway, and the water led off to the lower side by means of cross drains.

A case has been noted in which a swamp or bog of about half a mile in length is being crossed by a line at present under construction. This swamp or bog consists of a black soil somewhat like peat in its nature, which holds the water tenaciously. A ditch on either side of the embankment at a distance of seventy-five feet from the centre line was excavated down to the sand and gravel, a depth of three to six feet, but the water still stood between these ditches, and the bog material was about as impassable as before the ditches were cut. Cross trenches were then cut at intervals of about fifty feet, and boxes of three-inch plank, open at the bottom, were put in, with a result that the ground has now dried up sufficiently to enable the material from the adjacent cuts to be hauled on to it, and from present appearance, it is anticipated that the weight will squeeze the water out of the blocks of ground into which this is divided, and eventually give a dry and good roadbed.

The material excavated from cuttings should be built up in the embankment evenly, and in horizontal layers not exceeding three feet in height, each layer being carried out to full width at the particular height, and any stone or heavy materials should as far as practicable be placed

at the base of slopes. The best soil should be reserved for outer dressing, in the event of subsequent sodding or seeding.

Cases have come before the notice of the Committee where great trouble and expense has been caused by defective banks due to slidings of the material in large masses. Investigation by cutting the bank revealed the fact that when originally constructed, borrowed material of heavy blue clay had been deposited at the base of the embankment with an inclined top plane, and overlaid with surface material from cuts, and that there was a well-defined line of cleavage between the two materials. The sliding of the embankment occurred on this plane, and it may reasonably be inferred that if it had been built up level, such sliding could not have taken place.

Much depends upon homogeneity in the mass of the fill, and to this end it is advisable (especially in woodland districts where there is frequently a leaf mould overlying a substantial sub-soil) at the end of cuttings, to strip the surface soil, if it is light and porous, to a depth of eighteen or twenty inches below the grade line, and dump the portions of soil thus stripped into fills which would be a greater depth than two feet below grade. By this means, the sub-soil material in the portions of the roadbed immediately below grade would be continuous from excavation to embankment. Homogeneity in the mass is naturally a check against large moves, and at the top it is especially felt by giving a uniform firmness during summer, and a greater freedom from heaving in winter.

Experience shows that the slopes of cuttings, and more especially of embankments, when they attain their permanent set, are not the surfaces of planes, but more or less curved,—a rounding off at the top, and a curving out at the foot. Cross-sections taken for double track, and other extension purposes on roads originally single-tracked, show how such earthwork has behaved in the past. This being the ultimate natural result, and as the permanency of the roadbed is largely dependent upon nature, and how natural effects are either assisted or retarded, it is best at the outset, when such can conveniently be done, to further its attainment by rounding off these angles.

Allowance for shrinkage of embankments of three to seven per cent should be provided according to material and the way the fills are made. On the best made banks it would be better to provide for this shrinkage by bringing the roadbed up to sub-grade and making it wider than standard, instead of adding to the vertical height, so that when settlement takes place, there will be width enough to fill out, and not unduly run down the slope.

Where embankments are made on a side hill, deep furrows should where necessary be plowed in the slope, in order to bind the new material thoroughly to it; and in the case of widening out for double track, and sidings contiguous to the main line or in other similar circumstances, it is best if the banks are over four feet high, to give them similar treatment.

The practice of reducing initial cost by taking out cuts with a wide base and steep slope, is one in which the temptation to follow it in original construction is often great. It should be avoided when possible, as the ma-

terial is often of such a nature, that the sides soon begin to cave and slip, the result of which is the prohibition of first-class track until the defects be remedied, and the application of the remedy after the road is in operation almost invariably costs much greater than if it had originally been taken out to normal section.

The fundamental principle in maintenance is to keep the roadbed dry, and to insure this, every reasonable means should be employed to intercept the natural course of water from outside sources that would otherwise reach the roadbed, and then if by this means a sufficient degree of dryness is not attained, sub-drainage should be employed.

The surface ditches at the foot of slopes in cuttings being for the purpose of draining the roadbed, and also for the purpose of protecting it by intercepting and carrying off the accumulation of surface water on the slopes from rain, and that due to seipage, they should be of sufficient capacity to take off readily the water from the heaviest rainstorm, and of such shape as can most easily be cleaned from time to time. It is believed that in ordinary cuttings, a ditch nine inches deep, twelve inches wide at bottom, and slopes of one and one-half to one, generally meets these requirements. A true grade should be preserved for the bottom of these ditches and the greatest possible pitch given at their outlet.

In wet cuttings, where the soil is retentive of water, a supplementary sub-drain of tile, of six inches to ten inches in diameter, laid in the following manner, is of great advantage to the maintenance of track, and gives excellent results: a trench is excavated to just below frost line, in which the tiles are laid with ends abutting, engine cinders are placed over the tiles to a depth of two or three inches, and the remainder of the trench filled with coarse gravel or broken stone.

Occasionally in long and wet cuts, the size of the tiling should be increased as it approaches the outlet, increases from six inches to eight inches, and occasionally eight inches to ten inches, the enlargement taking place at intervals of one-quarter to one-third of a mile, and depending upon the amount of water tributary to the cut, but necessity for enlarging seldom occurs, and generally the same size will answer all purposes.

In cuts through ground sloping transversely, a ditch should be made on the upper side, to intercept the surface water which would otherwise flow over the slope; but the distance to make this ditch from the edge of the slope, as well as its general characteristics, must receive due consideration, for the soil may be of such a permeable nature, and become so saturated with water from this ditch, that injury will result to the slope.

It is often better to have a broken stone or tile drain on the top of the cut to collect and carry off the water, or else pave or box the ditch to prevent damage from the water cutting through the slope. In every case, however, where the general ground is sloping towards the cut, the nature of the soil should first be thoroughly examined, local conditions noted, and the main source of supply stopped or diverted where possible.

PROTECTION OF SLOPES.

Protecting the face of slopes on the older and more important lines is receiving much attention, and where done has been generally beneficial, and added much to the appearance. Sodding is the best and simplest method, if it can be well started and has sufficient proper soil to subsist upon. In most cases the extra expense of sodding, especially at time of original construction, will be made up in a few seasons by the security it gives against heavy maintenance charges. Sods from high well drained ground are the best, as those from swampy localities are apt, if exposed to the sunny side of a cut or fill, to dry out rapidly and disintegrate; still the latter can be used to advantage on the shady side of slopes, but the former are more resisting from their previous condition of growth. Sods for transplanting are best when about five years old, but in laying, extreme care is needed, and they should be secured by slender hardwood stakes driven well down into the ground, where the material on which they are laid is inferior.

Supplemental to the sodding, improved results can be obtained if for the first year a good mixture of timothy and oats seed be sown; it quickly forms strong roots and helps to hold the sod in place, afterwards as may be needed, a mixture of Kentucky blue grass, white clover, perennial rye, red fesco, and red top in the proportions of 8, 4, 9, 3, 8, respectively, making thirty-two pounds per acre.

Before sodding is begun, the slopes should be dressed to a reasonably fair shape. It is practically useless, however, to attempt sodding on unstable clay slopes which slide so deep as to carry away both sods and pegs, or on poor soil or barren slopes on which it soon burns out. When such conditions exist, other methods have to be adopted.

In warm climates, slopes of embankments composed of sandy material may be successfully protected by setting out on the embankment small tufts of Bermuda grass, planted about eighteen inches apart in each direction, the sod being collected and cut into pieces about six inches square. It is found that such frequently makes a substantial sod of Bermuda in twelve months.

Grass seed alone, even if the soil be fertile, is difficult to start on account of liability to washing away during rainstorms, but where it can conveniently and economically be used, it is well to do so. Manure from stock cars and cattle pens, as well as street sweepings which contain a large percentage of seed of various kinds, have been successfully used in producing an effectual sod in a couple of seasons.

These latter expedients are not intended for the more ornate features connected with station grounds, or slopes contiguous to a station, where lawn turf coming within the scope of landscape gardening is more applicable.

Excellent protection on some soils, such as silt or slippery clay, and especially as a guard against washing, where the embankment is alongside the course of a stream which rises and falls considerably, is attained

by planting willows. Such trees or shrubs are well adapted for the purpose, as they grow quickly, and are easily propagated from cuttings, and their masses of fibrous roots spread through the soil to a great depth, and hold the bank tenaciously.

Slag or ordinary rip-rap deposited in a layer of three feet or more in thickness below water, and two feet above water, has been found generally an efficient protection against abrasion of embankments subject to ordinary currents or the wash of lakes, etc. In heavy rip-rap, i. e., where large stones are used with fair regularity, the bed of each stone in the face of the wall should be laid at right angles to that face, and a "V" shaped trench dug, and foundation of the rip-rap laid in it, where there is danger of undermining and settlement of the rip-rap wall. Where the bottom is mud or quicksand, or liable to scour, brush may sometimes be satisfactorily used underneath the rip-rap.

An instance may be mentioned of a high bank which carried a track tank failing from the accidental overflowing of the tank, and which was successfully treated by first digging a trench outside the foot of the slope about four feet deep, and at such a distance from the foot of the bank that a broken rock slope could have an inclination of two horizontal to one vertical; the trench was then filled with rock, and the whole earth slope covered with rock. This protection was efficient, and considerably less expensive than masonry walls would have been.

There are many banks in which protection has been furthered by placing blind drains in the slopes at right angles to the line of track, consisting of loose rock put in ditches about three feet wide and four feet deep. Most of these banks had sloughed out more or less, and this sort of protection is an added feature, frequently after long use of the embankments; these broken stone drains serve the double purpose of carrying off sub-water, and acting as buttresses for the support of the embankment.

There are some instances where heavy cuttings exist through light sandy soil, in which the face of the slopes have been protected from the action of the wind, by covering them with a layer of clay from four to six inches thick. In this layer of clayey soil, grass and small shrubs take root, and serve still further to protect the slope. In sandy soils, good results are also obtained by spreading engine cinders over the slopes of embankments and cuts, and very little washing away of the soil then takes place. The use of cinders on the slopes of cuts also prevents the drawing in of large quantities of dust during the passage of trains.

RETAINING WALLS.

The general subject of retaining walls is an important one, and the Committee has in view an investigation of the general practice in a manner worthy of this importance. In subsequent reports it is the intention to present data and sketches illustrative of typical methods

adopted throughout the country. Meanwhile only a few notes are submitted in order that they may form a basis for present discussion.

Retaining walls are used to protect the sides of cuts and fills against continual slidings, by building up and then lessening the slope;— to curtail the spread of the slope of embankments on steep side hills, and that of cuts and fills where streets in towns are contiguous, or where land value is a vital matter of expense; they are also used in certain cases to prevent abrasion of the embankment by water, either by current or waves.

In fills, the walls are generally built in such location as to require the least masonry, and in cuts, the distance of face of wall should not be less than seven feet from the outside of the outside rail.

Permanent retaining walls are principally of masonry or concrete, or of both, the selection of the material being dependent on local conditions. They should generally have a batter of not less than one-quarter to one (although in some cases, as in cities or towns, they may have to be plumb), and be from two to three feet wide on top, with base four-tenths to one-half the height, dependent on the condition of the ground back of the wall, and the quality of the masonry.

Drainage of broken stone or coarse gravel should be properly provided at the back of the wall, if the soil to be supported is retentive of water; but if the ground is of clean sand or gravel, this special drain need not be made. Ample weep holes should in all cases be placed in the wall, otherwise there may be disastrous failures, and there should be a drain in front of the wall, and parallel with it, to receive the output of these holes.

Pile retaining walls at some points where the embankments are low have been made, and the walls tied transversely with iron rods, but this does not give permanent satisfactory results, neither do cribbing of old ties, sand bagging, etc., although these latter methods often tide over difficulties for a considerable time, and are valuable as temporary expedients.

IMPROVEMENT OF GRADES AND ALIGNMENT.

For lack of sufficient time, the Committee has as yet been unable to investigate in detail this important subdivision of its work, but a few salient features in connection therewith may be outlined in the meantime, as embracing the ground to be covered in future reports, and which for the present may form a basis for discussion.

Improvements of grades and alignment may be classed under two heads:—First, a complete change of location; and, secondly,—the lessening of the grades, and modifications of the curvature, as nearly as can be on the existing location.

Each railway or section of railway has its own special problems to solve in the matter, and no rules can be established which will absolutely govern every condition, but the best use should be made of all available data in order to apply it in the determination of a compre-

hensive and intelligent scheme of grade reduction. The modification of any existing grade is generally made only at considerable expense, and it is undoubtedly true that much money is spent injudiciously on such work through a lack of proper determination as to what ultimate economy requires. Several physical factors are involved, and various considerations obtain in every particular proposition of grade reduction, so that the solution of the problem becomes somewhat complex, and satisfactory results at least cost cannot be assured by working from off-hand assumptions.

It is therefore best that whether it be a complete change of location, or an improvement of the present one, the haulage features of each should be well worked out in connection with probable cost, in order to form an intelligent opinion as to the relative future value of each to capital expended. This part of the problem is freer from variable and complex factors than is the determination of locomotive efficiency, and what is required in that respect is a rational and adequate method for calculation in adopting a consistent and economical policy in grade revision. The present policy of many railways is undoubtedly erratic, and wide of economy, because of the failure to consider all the factors that apply to a logical solution of the problem.

The recent investigations carried out by a committee of the Southern Pacific Company, and embodied in a pamphlet, (which, through the courtesy of that organization, the Association has been enabled to publish as a Bulletin) is a long stride in the right direction, and the data therein compiled will be extremely valuable in attacking a problem which immediately confronts many railway managements.

The value of momentum in surmounting grades taken into consideration in calculating "virtual" or "equivalent" grades must not be lost sight of, as cases of increased load as high as 15 per cent have frequently been met with, when advantage was taken of the momentum; and grades should also be so revised, that in overcoming the heaviest, there will not be an undue excess or waste of power on the lighter ones, with all that that implies.

The controlling grade compensated for curvature, should be fixed if possible over a whole division, or at least a whole operating district, that is, the length of a freight-train run, in order that the loading of engines may be simplified, and the use of assisting engines avoided as far as possible.

In connection with either class of improvement, i. e., a complete change of location, or a modification of the existing one, the maximum grade and curvature should be decided, and the necessary compensation calculated for the curves, to make the resistance on them equivalent to that on a straight line. For example, on lines where tests have been carried out on an extensive scale, it has been found that 0.03 per cent for each degree of curvature for all curves up to and including 2 degrees, 0.04 per cent, above that and up to 4 degrees, is good practice.

For a high speed line, all curves 2 degrees and above should be spiral, taking a speed of 50 miles per hour, but in no case should the super-elevation of the curve be more than eight inches.

The tonnage in each direction should be figured out, as in some cases it may be practicable to adopt a heavier controlling grade in one direction than the other, according to the character of the traffic. It is possible on some districts that even with a reduction of grade a passenger engine will not haul any more tonnage over the new line than the old one, as local conditions frequently govern, and these have to be determined for each case. In that event, saving would be wholly due to the increased tonnage in freight service.

Having the statements of tonnage each way over the operating district, and the rating or tonnage capacity of the engine, as well as statistics of cost of the various items from the original line, it will not be difficult to form a very close estimate of the savings anticipated by the new line. The several items of operating and maintenance will be taken into account in making up the comparative saving in cost of maintenance and operating the new line, against which will be set the interest on cost of the change, including credit from material at reasonable figures taken from the old line, if it is to be disused.

In regard to tonnage rating, the specifications of a proper rating for any class of locomotives over its lines or divisions, is a matter of vital consequence to the management of every railway, and the investigation of this subject made by the committee of the Southern Pacific Company, as set forth in their report, must be in a greater or less degree appreciated by all interested.

It is scarcely possible to summarize intelligently their work in less space than is occupied by their published report. In examining the report it will be noted that the conclusions reached and formulæ adopted are the result of an application of simple mechanical principles and synthetical mathematics to certain selected data, this data compiled from well-authenticated experiments being presumably the most reliable and authoritative information of the kind extant.

For instance, the law of train resistance is assumed to be expressed mathematically by the equation or curve determined by Wellington. The curves for mean effective pressure are presumably based on a sufficiently extensive series of experiments with the locomotives of the Southern Pacific Company.

Having assumed these laws, and adopted the necessary units, the required formulæ are readily developed, from which may be tabulated the loads that may be hauled per unit of power at varying speeds on various grades, or inversely, for any given section of track it may be determined which grades, or series of grades limit the amount of load capable of being hauled over them, per unit of power at minimum permissible speed.

It is suggested that in the determination of locomotive tonnage rating for any given railway, as for instance, one where equipment

and permanent way are in uniformly excellent condition, or one with opposite characteristics, the assumed data may not apply.

It remains to be shown by the application of their formulæ in actual operation what approximation of accuracy the conclusions attain, and the testimony of any who have used the system will be heard with interest. Even though the process should not be infallible as a final means of determining the maximum permissible loading for any locomotive under a given set of conditions, it is submitted that a very few supplementary tests would suffice to show the necessary correcting factor.

The results of investigation of the various methods of work adopted in the actual reducing of grades on existing location, by lines with heavy traffic, is held over until subsequent reports.

TUNNELS.

Consideration of the means of ventilation and maintenance of tunnels is reserved for a future report.

W. McNab, *Chairman*; Assistant Engineer Grand Trunk Railway System, Montreal, Canada;

C. Dougherty, *Vice-Chairman;* Roadmaster Illinois Central Railroad, Chicago, Ill.;

R. C. Barnard, Engineer Maintenance-of-Way Pennsylvania Lines West, Cincinnati, O.;

H. Baldwin, Engineer Maintenance-of-Way Cleveland, Cincinnati, Chicago & St. Louis Railway, Indianapolis, Ind.

Committee.

The President:—We will call on Mr. McNab for any remarks he desires to make in connection with the report, and then throw it open for discussion.

Mr. W. McNab (Grand Trunk):—I think it is fortunate that on account of some of these reports having been printed and distributed a little in advance of the annual meeting, the formality of reading them can be dispensed with. You will remember last year a great deal of valuable time was occupied in this way, and such can now be spent to much better advantage in discussion afterward. Before formally presenting the report, however, I would like to make a few remarks, and first, in regard to the name which is given to the subject-matter under control of this Committee—"Graduation." I do not know whether or not, at the time of the formation of this Association, any discussion took place on the selection of this word "Graduation," as intended to embrace the various works connected with cross-sections, drainage, protection of slopes, retaining walls, improve-

ment of grades and alignment, and maintenance and ventilation of tunnels. It is true that this word is in frequent use, and as applicable to railroads is generally intended to cover grading, but our standard dictionaries do not qualify it as such. We find such definitions as a division of space into small intervals, the conferring and receiving of academic degrees, or the reduction of a liquid to a certain consistency by means of evaporation; and such are the universally recognized meanings of the word. And I bring this matter up now, in order that this Association may not only be the authority on methods of work, but also on the nomenclature and synonymous terms referring to that work.

In regard to a change of name, it does not appear to me that even the word "grading" is sufficiently complete to embrace all these subdivisions, and if I may be allowed to make a suggestion—and it is done in order that there may be an expression of opinion at the proper time—I would recommend that the term "Roadbed" be given as the subject-head for this Committee. It certainly would embrace all matters connected with cross-sections, their drainage, protection of the slopes of the roadway, the improvement of grades and alignment of the roadway, and also the maintenance of tunnels, together with their ventilation, which latter element has an important influence upon the roadway in tunnels. I hope that at the proper time the President and any members who may feel sufficiently interested will discuss that point.

Now, as to the report itself. It may not be out of place for me as chairman of the Committee to characterize it as a progress report, pure and simple, and it is hardly necessary to use more emphasis in connection therewith than to make a simple statement of the fact that the field of inquiry, research and observation, and the general scope of the work intrusted to our investigation is a large one. To overtake all within twelve months, or in any prescribed time, was never contemplated by the Committee. We took the ground that this Association, through its standing committees and the discussions arising from their findings, is practically the authority on maintenance matters, and it was better, therefore, to get a portion of the work into such a shape that some practical use could be made of it and good results be obtained, rather than treat the whole of it in a superficial or semi-

complete manner, and thereby have the effect of retarding the attainment of what I may call the essence of the sum and substance of the objects of the Association, namely, the being able to secure the best permanent value out of any work with the least means at disposal. With this in view, it was determined to take up first the subdivision relating to cross-sections, that being a matter that every railroad is primarily and directly interested in. Existing roads may find some benefit from it in regard to future improvements, while new projects should profit by it from the very outset.

It may perhaps be considered, and not unreasonably, that the third subdivision of this work—that relating to the improvement of grades and alignment—might have been investigated in detail first, as being a matter of paramount importance on many lines, where keen commercial competition due to economical hauling has to be contended with—a competition more keenly felt day by day. But as to that, the Committee considered it was a very large subject, and to present it in the manner in which they hope to present it meant a larger amount of time than they had at their disposal. Moreover, the excellent and exhaustive report on locomotive tonnage rating on the Southern Pacific—which through the courtesy of that company we have been able to publish and distribute among the members—contains in itself sufficient matter for discussion, if need be, on that important subject. The same views in general were taken in regard to the matter of retaining walls, and also tunnels. We hope eventually to be able to present a report on each of these questions in a manner becoming this Association.

It may be stated that our Committee is, numerically speaking, very small. We have had a few defections in our ranks; one member has been amicably transferred to another committee, and we have lost the head of our Committee by reason of the large duties devolving upon him on the road with which he is connected, and which prevented him from devoting time on this matter, and it may be necessary before the close of the convention to have our Committee supplemented.

I will close by stating that this report is simply intended as a basis for discussion, and it is hoped it will be criticised in as full and complete a manner as possible. After all, the discussions

which take place on a report are often the best part of the report, or rather the best part of the information which comes up in connection with the presentation of a report, and I hope you will handle this one without gloves, so to speak. Nothing gives greater help in getting at the root of a matter, or more zest in prosecuting further research, than a free and healthy discussion of the report and work of a committee upon the particular subject-matter involved, so I hope that the members will bear that in mind, and not be backward in giving their opinions upon the subject. We will accept it as a criticism on the subject presented, rather than on the Committee.

The President:—For the information of the members I will state that the designation of the committees and the placing of the members thereon, under our Constitution, is in the hands of the Board of Direction, and any discussion having reference to the designation of committees will be considered by the Board and taken under advisement, if the members generally should express a desire for a change in the name, and the same applies to the membership of the committees.

This Committee will have to be enlarged. They have done excellent work—considering the size of the Committee. It has been the intention of the Board of Direction, in the appointment of members to committees, to have all roads represented on some committee or other, no member to be required to serve on more than one committee. In addition to this, the wishes of the chairmen of committees have been considered, and also the preferences of the members of the Association. If there are any members who have not been appointed on committees, who would like to serve on one or the other of the various committees, they are requested to communicate their wishes to the Secretary, and they will be considered when the committees are reorganized. Also, if anyone is on a committee where the work is not congenial, or desires to be transferred to some other committee, if he will communicate with the Secretary, arrangements will be made for a transfer.

It can readily be seen that, widely separated as our membership is, and the Board not being personally acquainted with all the members, or their qualifications, it was an extremely difficult matter to constitute these committees properly; but it was always

intended that their constitution should be revised and adjusted year by year, as the members became better acquainted with the work and with each other, and with the members of the Board.

Mr. D. D. Carothers (Baltimore & Ohio Southwestern):—I was very glad indeed to hear the question of the title of this Committee brought up. It was a matter I intended to bring before this meeting. It seems to me very unfortunate that we should use any word in the transactions of this Association that does not have an exact and correct meaning. I believe the first time "graduation" was ever used in a specification was on the Cincinnati Southern Railroad. I do not know how it came to be used. The specification was an elaborate one and it was copied by many other roads. I think in that way the word came into general use, although it does not strictly apply. I have it in some of my specifications, although I think it would be unfortunate to continue its general use. As stated by the President, I presume it is not in order here for a motion to correct the title of the Committee, and suppose that will be a matter for the Board of Direction. I hope they will take it up.

The President:—I have no doubt but that the question as to the propriety of continuing the use of the name of this Committee will be taken up by the Board. Mr. Camp, you have paid a good deal of attention to this question.

Mr. W. M. Camp (Editor Railway and Engineering Review):—I have not read the report over, Mr. President, but I notice one thing that I wish to bring up, and that is in regard to the width of roadbed. The Committee states that the minimum width of roadbed on embankments should be 20 feet. I have no fault to find with that width, but from the language of the report one might infer that it is expected that that width may in cases be exceeded. I would be glad to learn to what extent a roadbed of 20 feet is exceeded on any of the roads having representatives here. I have found only one road that has a width of roadbed as great as 20 feet, and that is the Illinois Central. Of course, it is not to be inferred from this that it is the only road having such a standard width, but I think the roads are comparatively few that have a roadbed width of 20 feet as a standard.

Mr. McNab:—Mr. Camp may be correct in his assertion, but I think it is the intention of some of the principal roads to attain

that width eventually. Twenty feet has been put down here as a minimum on what may be termed a first-class road. We certainly must have some standard in view, and I think it is better to assume a high-grade standard than a medium-grade one. There is no doubt whatever as to the benefit of a wide roadbed, and the Committee have expressed it in this way in order that roads contemplating improvements or extensions may have this in view. I am not aware personally whether that width is exceeded, but I am personally aware that some of our principal roads are striving for that.

Mr. G. A. Mountain (Canada Atlantic) :—That clause struck me relative to the width of roadbed. Our standard in Canada is 20 feet, excavation and cuts, and 15 feet embankments. I think that is very small, but a 20-foot roadbed in a cutting, particularly when you allow for ditches, would be a pretty big cutting.

The President:—With reference to the width of roadbeds—that is, for a first-class road—where it is desired to have rock ballast about 18 inches deep, providing for a shoulder outside the edge of the ballast to the edge of the slope of the embankment, with sufficient width for a workman to stand on, and also making allowance for protecting the ballast so it will not roll down the embankment—it will be found that 20 feet is an economical and practical width. Even with a standard of 20 feet it is very difficult to attain and maintain an actual width of from 17 to 18 feet, due to the invariable washing-off of edges during the progress of the work. The object of carrying the 20-foot section through the excavation is that it does not break the continuity of the shoulder-line, as it is a difficult matter to lead the ditches in a way that will avoid cutting into the embankments. The economy of regularity of sections and width of embankments is considerably affected by the proper maintenance of wide roadways. I have personally passed over miles of well-ballasted roadbed in rock where more money was wasted on the rock or gravel ballast—or whatever the ballast material that was used—that had slipped down the sub-embankment or had been used to fill up depressions in the roadbed, than it would have cost to maintain the wide, uniform and well-lined sub-roadbed.

In track work, the foundation of the track, and the one thing upon which all future work depends, is the sub-roadbed. That

should be uniform and on a level. It should be uniform in width and should be ample in order to give stability to the structure you put upon it. The first structure you put upon it is the ballast. Without a roadbed of liberal width—level, true and well-lined—ballast is wasted, and is doubly expensive to maintain. On the Illinois Central Railroad the standard width of 20 feet is endeavored to be maintained on the important main lines. On lines that are secondary, the width is 18 feet. Branch lines that are ballasted only slightly with gravel, or are ballasted with cinders, are sometimes made 16 feet, but 16 feet is the minimum even on lines over which only about four trains a day are operated. Twenty feet is the standard on lines intended to be full-ballasted—on principal, main lines.

Mr. Mountain:—What would that make necessary in the excavation?

The President:—That would make 32 feet. I beg pardon for taking up so much time, but this is a matter in which I have always taken a great deal of interest, therefore I answer the general question.

Mr. P. Alex. Peterson (Canadian Pacific):—With this minimum width of 20 feet, what depth of ballast is your allowance?

The President:—For one foot of ballast under the tie, would make a ballast of rock of about 18 inches in thickness.

Mr. Peterson:—What shoulder at the end of it?

The President:—Our original shoulder was a foot beyond the edge of the ties, but the tendency is to increase that width to about 18 inches.

Mr. D. W. Lum (Southern Railway):—It occurred to me that perhaps 20 feet is a little wider than necessary to give a good support to the ties and ballast, and if it be more than is necessary, perhaps it is incurring a greater expense than would be warranted in maintenance-of-way work, and possibly we might spend that money for something else that might be more needed in that same department. An 8½-foot tie, with a 20-foot roadbed, would allow about 5 feet 9 inches outside of the end of the tie, that is, to the edge of the roadbed, and it costs some money to maintain that area during the year, that is, in the way of grassing or sodding, as the local situation may require, and it seems to me that 18 feet would be sufficient for a roadbed, and that we devote

our surplus money to more ballasting, heavier bridges and heavier rails. There are very few roads in the United States that have a roadbed exceeding 18 feet—that is, in practice.

Mr. McNab:—In reference to the remarks of Mr. Lum, he took up a point about the increased maintenance account, and I understood it to refer also to the protection of the slopes with grasses or sodding. It seems to me that that matter has hardly to do with the width of the roadbed, the sides and slopes being made practically the same.

In reference to the width of the roadbed, on one of Canada's first-class roads nearly fifty years ago the width at subgrade was placed at 18 feet, and in cuttings at 22 feet, and while during the period between then and now the bridge structures have undergone renewal a number of times, and been made stronger to meet the increased weights of rolling-stock and increased speeds, nothing seems to have been done to make the ordinary roadbed and embankments more substantial; and as speeds are being further increased, and the rolling-stock being made still heavier, I think it is well to have some definite substantial standard in view to attain.

Mr. Lum:—I did not refer to the slopes of the embankments. It was the area between the end of the tie and the top of the slope which has to be taken care of in a neat manner, either by grassing to expose the soil or the dirt underneath, or to sodding and maintaining the sod in a neat and presentable way. I think that 18 feet width in the roadbed is sufficient to maintain or support the tie and its ballast.

Mr. McNab:—Then it was a misconception on my part.

The President:—Mr. Dougherty, what is the width of the ballast on the bottom of the subgrade on your line?

Mr. C. Dougherty (Illinois Central):—The width of our ballast on bottom of subgrade is 15 feet. With a width of subgrade of 18 feet, that will only leave 1½ foot from the edge of the ballast to the edge of the slope of the subgrade. We find that after the grade is put up it does not take long for the corner of the embankments to wear off, and with a subgrade width of less than 20 feet, we have a great deal of trouble in keeping our ballast in place. It is evident that as soon as the slope of the ballast begins to get out of place the support of the tie—especially at

the end of the tie—is weakened, making it more difficult to hold the track in line, and developing a greater tendency toward centerbound track. Our experience with a 20-foot subgrade has taught us that anything less than that would not be sufficient on a line where the traffic is heavy and the track is full-ballasted.

Mr. G. W. Kittredge (Cleveland, Cincinnati, Chicago & St. Louis):—I quite agree with the Committee that on roads that are considered first-class roads, a minimum width of 20 feet should be considered the standard. We had occasion recently to build a short cut-off line. Our specifications for that line provided that the width of the roadbed, exclusive of the ditches in the excavation, should be 24 feet. As the line was one that we wanted to construct cheaply, we specified that the width of the embankment should be 16 feet. The object of making the distinction was that, in the cuts especially, we wanted good drainage. The fundamental principle of all good track is good drainage, and that cannot be obtained if the excavations are too narrow, and my observation is that it is always easier to widen embankments than it is to widen excavations after they are once made. So that in the case of this line, which we wanted to construct cheaply, we made the embankments 16 feet, expecting some time, as opportunity offered, to widen it out to the full width of 20 feet. But we wanted the cutting of sufficient width so as to enable us to drain our track well and maintain it there. I bear in mind some stretches of track that have been very materially improved, and the cost of maintenance reduced very largely, simply by widening the cuts. The cost of widening the cuts from a width of 17 or 18 feet to a width of 20 feet, exclusive of the ditches, has been less than was actually spent on labor in maintaining. The labor for the widening of the cuts has been less than that actually spent in keeping the track through those narrow cuts in good surface during the winter and early spring, when the frost and moisture particularly affected it.

Mr. R. Trimble (Pennsylvania Lines):—I would like to ask Mr. Kittredge where he expects to get the material to widen this embankment when he wants to make it 20 feet wide?

Mr. McNab:—I was about to ask Mr. Kittredge that question. I presume that to avoid waste, he had fixed it up on a grade line. Probably Mr. Kittredge is looking forward to an

improvement of his grade, and later on to get material to extend his banks.

Mr. Kittredge:—The particular place referred to happened to be in the near vicinity of a gravel pit, where we have every year or two years to do quite a little stripping in order to get our ballast. That was laid on a uniform grade of 10 feet to the mile, and we expected to get from the gravel pit some material in the near future to widen those banks and also from cleaning out the cuts in territory not too far distant from this location.

Mr. J. B. Cox (Chicago Junction):—I would like to ask the chairman of the Committee if he has taken into consideration the length of ties used for an embankment 20 feet in width. Some roads use ties eight feet in length, and others eight and one-half.

Mr. McNab:—I had some communication with the Committee on Ballasting in regard to that. I thought that we might have been able to submit a typical section of roadbed for this meeting, showing the ballasting and the ties, and that we might have had an exchange of views with the Tie Committee, and also the Ballasting Committee, and perhaps arranged that these three features might have been shown on one sketch or plan. As far as the Committee on Graduation is concerned, we have not taken the length of ties into account, nor yet the ballasting, but we had considered 8 feet 6 inches for length of ties, although there is nothing official in that statement.

The President:—That does not cut much of a figure, because with an 8½-foot tie, the tie is only three inches longer on each side than with an 8-foot tie. There should not be among engineers—there may be among railway managers who are not engineers—an exaggerated idea as to the cost of an increased width of embankment. To increase the width of an embankment 13 feet high by two feet only requires a cubic yard of earth for each lineal foot of embankment. At 20 cents a cubic yard—the ordinary average price, I presume, throughout the middle of the United States—would only mean 20 cents a foot to obtain the additional width of two feet for the roadbed. This, of course, does not apply down in the Carolinas, where you have solid rock or high embankments, or a long haul, or anything of that sort. I simply offer these figures as applying to what might be called the Middle West.

Mr. Lum:—Of course, this discussion only refers to embankments which are expensive, which mean days and days of work trains and men to widen perhaps two feet.

The President:—For this reason I think it is better to build the embankments wide in the first place.

Mr. Lum:—I think so, and I wish to indorse the recommendation of the Committee, that when a road is constructed a sufficient width be given, so that when the shrinkage takes places we shall still have an embankment of 18 feet, which seems to me is wide enough. The cuts, I think, should be as wide as possible, and the wider the better, as Mr. Kittredge says, to insure the drainage and the drying-out of the roadbed away from the ties and toward the back of the ditch.

Mr. C. A. Wilson (Cincinnati, Hamilton & Dayton):—I think the gentlemen are beginning to get together now on the point as to the width a roadbed should be constructed at subgrade. The Committee, as I understand it, has made a recommendation as to what width the road should be first or finally constructed, while the discussion has been upon the width to be maintained; and the thing we should aim to have done is to get a roadbed constructed, which is a charge to capital account, to require after it is built the least expense for maintenance, which is an operating charge. If this is borne in mind, the discussion should be confined to the width of roadbed which should be constructed, so that the cost of maintenance thereafter would not be too high.

The President:—Our subject is so broad that I presume it will be impossible for us to give the time to discuss all features of this report. As we have covered this one feature quite fully, and as we have four other important committees to-day, we will consider the discussion closed, unless Mr. McNab desires to make some further remarks.

Mr. McNab:—If I may be allowed one minute, there is one particular feature here that I commend to the attention of the members, and that is the shape of the roadbed. We have here made a statement—not, however, that it is the actual recommend of the Committee—that simple drainage planes sloping each way from the center have been found effective. Now there are a variety of sections, as you know, adopted by the different

railroads, and some are very fantastic in appearance. Some of them may be right enough where they are built for a single or double track originally, but when it comes to widen them out afterward for a double track or additional tracks, how are you going to make the extension on the same principle? That is a matter I had hoped there would have been some discussion upon, but we will reserve it for a future time.

The President:—There is no doubt but that any of the subjects treated by either of our committees could be profitably discussed for the entire time that will be devoted to all of the reports, and we have only touched one of the subjects of this Committee's report. It seems to me that rather than spend our time over every item of the reports, we should take up one or two subjects—as we have this question of excavations—and discuss it thoroughly. It would probably be more beneficial than to scatter our time over the entire report at a single meeting.

There is another matter to which I would like to call attention, and that is, if any member is too modest to get up and criticise these reports in this meeting, or if some idea occurs to him after the close of the sessions that will throw light on these matters—if such member will send his criticisms and suggestions to the Secretary, they will be considered and published with the discussions of the different reports, which are to be printed at the close of this meeting. It will be several weeks after the close of the meeting before the proceedings are printed, and the discussions and remarks of each member will be sent to him for examination and correction, so that you will all have an opportunity to fully discuss any of these questions by letter.

The Committee of Arrangements is very desirous to settle the question of details and the seating of the members at the tables at the banquet, so that each member entering the banquet hall to take his seat may be furnished with a list and a diagram, showing the location of every member and guest in attendance. In order to do this it is necessary that the Committee have the names and seating of those desiring to attend, and if you will kindly attend to this, it will make the banquet much more interesting to be able to know just where everyone is located.

Mr. E. B. Cushing (Houston, East & West Texas, by letter):—The idea of this Committee to hereafter submit types of

roadbeds which will begin with an ideal one for a first-class road and embrace others for small roads and unimportant branches is a very good one. I would only suggest that in considering the matter they begin with what may be considered the cheapest type and build up on this until they reach a section that may stand as an ideal one for a first-class road, instead of modifying the first-class type for smaller roads. This would be following on paper the process of development as it takes place in practice. It has fallen to my lot to be engaged in improving some of the worst constructed roads in the South, and I have often thought how a little forethought on the part of those who built the roads would have saved time and money in the improvement work. The majority of specifications 25 years ago in our section called for embankments 12 feet wide and excavations 18 feet wide at subgrade—the latter width being from out-to-out of ditches. Some specifications demanded a distance of 10 feet from outer slope of excavations to the spoil bank, but on many roads the excavated material was deposited just clear of top of slope. The berms of embankments were likewise narrow, and no attempt made at drainage of borrow-pits. When the work of improvement is undertaken, this condition causes greatly increased expense. Whereas, to have required waste piles to be 15 feet from top of slope of excavation and exacted berms 10 feet wide, when the roads were originally constructed, would have added very little, if anything, to the cost. Hence the suggestion that the typical plan for the poorest class of road should show such measurements of berms, waste pile, etc., as will not interfere with the improvement work, should it become practicable and desirable in after years to bring the road to a higher standard, and therefore to apply a different typical plan. There are, no doubt, other members who would be as interested as I would to have this Committee study the maintenance of roadbed across swamps and "bogs." A particularly annoying case once came under my observation. The line of survey crossed a swamp for several miles. There was a thin, hard crust of matted vegetation and mold that would bear the weight of a team, but when this was cut through the underlying stratum was a blue muck, into which a range pole could be run six feet without much effort. The engineer in charge, finding it impracticable to build the embankment with

wheelbarrows, adopted the rather unique plan of building the road with dredge-boats. Canals parallel with the center line were excavated, leaving a narrow berm between the canal and the slope of embankment; the excavated material was deposited so as to form the roadbed, and when the material dried out it made a fairly good road. However, the real trouble began with the operation of the road. The embankment was about four feet high—as I remember it—and it would often sink six inches in 24 hours. The roadmaster would meet the emergency by depositing additional material on the embankment and surfacing the track, hoping that some time the hauled material would "strike bottom," and they would thus get firm roadbed. After a while it was observed that little mounds were rising in the marsh or swamp near the roadbed, and it was decided to discontinue work on the plan theretofore pursued, as these mounds indicated that the deposited material was being forced into the muck and the prospect of a solid roadbed was remote. There was then tried a plan of building a false berm—a mat of brush was laid outward from the foot of the bank and this was weighted with earth and old ties. This plan was much more effectual, and reduced the tendency to settle, though I believe it did not entirely remove the trouble. Having occasion to build a road over a similar swamp after that time, this plan was adopted on construction: A "corduroy" road was laid by using the trees and brush cut from right-of-way; this mattress extended about 16 feet outside of the slope stakes. Material was hauled in on wagons from the dry ground at edge of swamp and the mat covered about 12 inches; then the embankment was built up. When the limit of economic wagon haul was reached, a two-pile temporary trestle was built and train backed out to deposit dirt. No settlement has taken place beyond the natural solidification and consequent shrinkage. I would be glad to hear of any other plan successfully tried in such cases. There are many of these kind of "bogs" in the Gulf Coast country.

Mention is made in the report of Bermuda grass. Some years ago we had a cut that caused us annoyance and expense by continually sliding and filling up the ditches. We tried everything we knew of to stop this sliding, but without permanent results. We then sodded the cut in the beginning of the dry

season, when rain was not expected, and watered the grass twice a week, using a spray worked by a siphon on the work engine tank. The grass took root and grew splendidly, and by the beginning of the rainy season the slopes were well covered. There has been very little sliding since, and we regard Bermuda grass as a "good thing."

Mr. D. MacPherson (Canadian Pacific, by letter):—The proposed minimum of 20 feet at subgrade is too wide for banks, as all that is necessary is a berm of about 12 inches beyond slope of ballast to prevent it wasting down the side of embankment. A width of 18 feet is ample for this.

The idea that material taken from cuttings "should be built up in the embankments evenly and in horizontal layers not exceeding three inches in height," etc., is all right, theoretically, and in some cases it may be necessary to do so, but in the majority of cases there are great practical difficulties in the way of doing so, especially where deep gullies with steep sides are being filled from adjoining cuts. It would be practically impossible, and in many cases needlessly expensive, to make roads down sides of slopes to start fill at bottom, and it would not be advisable to do so unless the foundations were such that slips were liable to occur.

The Committee's report covers so much ground that it is perhaps not reasonable to expect that they should have gone much into detail figures, but it appears to me that the matter of virtual or equivalent grades is too live a question at present to have been so casually mentioned. It is to be hoped the Committee will go into this point deeply for next year's report.

The President:—We will now call on the Committee on Yards and Terminals, of which Mr. Sullivan is chairman.

REPORT OF THE COMMITTEE ON YARDS AND TERMINALS.

To the Members of the American Railway Engineering and Maintenance-of-Way Association:

Your Committee, in presenting its first annual report, desires to state that it has held eight meetings, at most of which five of the members have been present, and at which various matters have been carefully considered and discussed. There has also been correspondence with the several members in regard to certain points under discussion.

As stated in the preliminary report presented by this Committee, at the first meeting of this Association, in March, 1900, comparatively few railways are in a position to consider questions arising in connection with terminal work, free from the limitations imposed by the existence of facilities already established. It is believed, however, that many errors in design in such work may be avoided by the elucidation of the principles which appertain to the different branches of terminal service. In its deliberations and discussions, therefore, the Committee has carefully considered the practical points involved as well as the broad question of what would be the best practice apart from such limitations. In brief, the aim of the Committee has been to present principles and typical methods of practice which are generally applicable, and not to lay down standards which must of necessity be departed from in view of the controlling influence of the limitations above referred to.

TERMS AND DEFINITIONS.

The first work of the Committee was to consider the terms used in this branch of the service, with a view to the adoption of a series of standard terms, as well as to formulate definitions of these terms, in order to have a common understanding in the discussion of the various questions. It was found at the outset that even among the members of the Committee the same term had different meanings, and different terms were applied to the same thing. From this elementary confusion there has been developed a series of terms and definitions, which it is hoped will gradually come into general use. Your Committee believes that it is of importance in establishing a foundation upon which to base the continuance of its work.

One of the first difficulties encountered was in regard to the too frequent and indiscriminate use of the word "Yard." This term is now generally applied to the single set of switching and storage tracks at small stations; to each of the several independent sets at large terminals or division points, and also to the entire series of such sets at the same points. Thus a "yard" may be composed of a number of "yards" (receiving, separating, classification, storage, departure, eastbound and westbound, etc.). Colloquially, this produced but little confusion, but it does produce confusion when the questions involved in yard design and operation come to be considered technically. After having encountered this difficulty several times, your Committee concluded to take the radical step of adopting a new term to designate the entire series of "yards" at important points. The term adopted, after some discussion, is "Cluster," which, according to Webster's Dictionary, is "A number of similar things collected together or lying contiguous; a group." This definition seems fully to meet the requirements.

The word "Terminal" has been taken to include all the facilities provided for terminal work, on a large or small scale, while the word "yard" relates only to one set of the tracks which are used for the

switching or storage of cars. Terminals may be divided into freight or passenger terminals, and may be further classified as line terminals, division terminals, district terminals, branch terminals, etc.

With these explanations, your Committee presents the following list of terms and definitions:

TERMINALS.

TERMINAL.—The facilities provided by a railway for the conduct of its business at the end of its line, or of a division or a district.

FREIGHT TERMINAL.—The special arrangement of terminal facilities for the handling of freight business.

PASSENGER TERMINAL.—The special arrangement of terminal facilities for the handling of passenger business.

YARDS.

YARD.—Three or more parallel tracks arranged in series for the convenient switching or storage of cars.

RECEIVING YARD.—A yard for the reception of traffic.

SEPARATING YARD.—A yard next in order to the receiving yard, in which the traffic is separated by districts or commodities, as may be required.

CLASSIFICATION YARD.—A yard next in order to the separating yard, in which the traffic is classified in accordance with requirements, and made up into trains.

DEPARTURE YARD.—A yard next in order to the classification yard, in which trains are placed awaiting departure.

STORAGE YARD.—A yard in which cars are held awaiting disposition.

CLUSTER.—An arrangement of yards in series, for the separation, classification and storage of cars.

GRAVITY YARD.—A yard in which the movement of cars is produced by gravity alone.

ASSISTING GRADE.—The elevation given one or more tracks of a yard to facilitate the movement of cars.

POLING YARD.—A yard in which the movement of cars is produced by the use of a pole or stake operated by an engine on an adjoining parallel track. The movement may be facilitated by an assisting grade.

SUMMIT YARD.—A yard in which the movement of cars is produced by pushing them slowly over a summit, beyond which they run by gravity. The movement from the base of the summit may be facilitated by an assisting grade.

TRACKS.

Body Track.—One of the parallel tracks of a yard upon which cars are switched or stored.

Ladder Track.—A track connecting in series the body tracks of a yard.

Lead Track.—An extended track connecting either end of a yard with the main line.

Drill Track.—A track connecting with the ladder and used exclusively for movements in yard switching.

Open Track.—A track reserved for movements through a yard.

Running Track.—A track reserved for movements through a cluster.

Cross-over Track.—A track connecting two adjoining tracks.

Special Tracks.—In a typical yard there will be several tracks devoted to special purposes, varying with the local conditions. These will include caboose tracks, scale tracks, coaling tracks, ash-pit tracks, bad-order tracks, repair tracks, icing tracks, feed tracks, stock tracks, transfer tracks, sand tracks, depressed tracks, etc.

LOCATION.

The location of a yard or cluster depends primarily on the necessity for a readjustment of the formation of trains for purposes of distribution, and should be within reasonable distance of the areas which yield traffic for movement over the line or to which traffic arriving from the line must be delivered.

Within such limits as convenient and economical operation make practicable, the location may be adjusted to suit the topography of the ground so as to obtain the benefit of such natural advantages as may exist having reference to grades and drainage, also to cost of land and size and shape of sites available for the purpose.

More in detail, it may be said that the location should be convenient to the business terminals of the road, to the freight houses, team tracks and to the points of interchange with other roads or divisions, and should be arranged so that trains can enter and leave the yard without crossing the path of other movements. Where possible, advantage should be taken of natural grades to assist in switching. In some locations assisting grades cannot be had; in others grades can be had in one direction; while in others grades can be used to help in each direction. The assistance of grades is an advantage.

The size of the yard should be roughly estimated and the points available should then be selected. The cost of property, grading, drainage, etc., should now be considered, and the advantages and disadvantages of each possible location summed up; these figures should include cost of operation, interest on first cost, etc.

The advantages of different locations will then become apparent, and a selection may be made of the most advantageous.

RECEIVING YARD.

In regard to the design of yards, the Committee first took up the question of freight service at a line terminal (or the actual end of a railway company's line). Considering this matter in proper sequence, we have first the receiving yard, which receives the freight trains coming in off the road. Here the road engine and caboose are cut off, and the work of assorting and distributing the cars is taken in hand by the switching engines and crews. It is very generally assumed that the length of tracks in the receiving yard should be sufficient to accommodate the longest train entering the yard. This does not hold good invariably, however, for the reason that, where very few trains are of the maximum length, the adoption of the maximum length of tracks may involve unnecessary expense as well as an unnecessary amount of switching movements. Under such conditions of traffic it may be preferable to provide for the average train, leaving the maximum train to be taken care of by special means or special movements. The proper length of track for a receiving yard is a relation dependent upon the unit selected, and is governed by the following factors:

1. Length of train of loaded cars.
2. Length of train of empty cars.
3. Average length of trains.
4. Number of trains of average length per day.
5. Number of trains of maximum length per day.

Consideration should also be given to prospective changes in grade and to possible increase in the length of trains entering the yard.

The length of train is the controlling factor and the logical unit. The Committee has arrived at the conclusion that when the trains of maximum length represent less than 20 per cent of the total number of trains entering the yard daily, then the average train length will be the most practicable basis for a receiving yard having tracks of equal length. The yard may, however, be constructed with a portion of the tracks of sufficient length for maximum trains, and the remainder of the tracks of sufficient length for average trains. In this case, the tracks of each group should be of equal length. Whichever unit is taken (the maximum or the average train), the track should be of such length as to accommodate a train with two engines and a caboose. If the average train length is taken as the unit, then the length of track should be such that a train of the maximum length can be disposed of on not more than two tracks.

The proper size of the receiving yard is a relation dependent upon:

1. The frequency of the arrival of trains.
2. The rate at which cars can be received and disposed of in the separating yard.

The Committee lays down the principle, however, that the receiving yard should have a sufficient number of tracks to hold the trains arriving during one hour of maximum traffic.

SEPARATING YARD.

This yard is the second in the series, and here the first breaking up of a train and the distribution of its cars is effected. The cars entering the yard are usually distributed so that, according as the separations are to be by districts or by commodities, the cars destined to assigned districts, or containing the same commodities, will be placed together on separate tracks. The yard should be located in advance of the receiving yard, and in such a way that cars can be readily moved into it. The number of tracks in the separating yard should be governed by the number of separations to be made. The length of these tracks should be determined by the number of cars for each separation, and there should be extra room allowed for emergencies.

CLASSIFICATION YARD.

Here the second distribution or assorting of the cars is effected. When the separation in the preceding yard is by districts, the purpose of the classification yard is to put the cars of the different districts in regular order. Thus the cars of each district (already placed on one of the tracks of the separating yard) are switched in the classification yard in the order required for delivery at destination. When the separation is by commodities, the cars of each commodity (already placed on one of the tracks of the separating yard) are further assorted by classes or grades. Thus all the cars of grain, placed indiscriminately on a track in the separating yard, will be rearranged in the classification yard so that the cars of wheat, corn, oats, etc., are each grouped on separate tracks. The classification yard should be located in advance of the separating yard, and in such a way that cars may readily be moved into it from any of the tracks in the latter yard. It is usually in the form of a gridiron, and its capacity will be determined by the number of cars going to a district, with ample allowance for an excess number or for emergencies. As an example: With 36 cars going to a district, two "gridirons" of six tracks each, with a capacity of six cars to a track, will give such control of the entire set of cars that it can be turned end for end, or car for car. This type of yard may be made up of a series of parallel stub tracks instead of gridirons; such an arrangement is sometimes termed a lancing yard.

DEPARTURE YARD.

In this yard the trains made up in the classification yard are held awaiting departure. Here the work of the yard engines and their crews ceases, and that of road or transfer engines and their crews

is commenced. It should be located in advance of the classification yard, so that cars from all tracks in the latter can be readily moved into the departure yard. The number of tracks and the length of tracks in this yard are governed by the same requirements as those governing the receiving yard.

STORAGE YARD.

This yard is for the reception of cars which have to be stored or held awaiting disposition, instead of being put into trains and sent forward. The location of the storage yard is very important and depends almost entirely upon the character of the cars to be stored or held. Three distinct cases may be mentioned:

First—On some railways, it is known in advance that entire train loads of business arriving will have to be held. In such cases, the storage yard should be located with or in close relation to the receiving and separating yards, so as to permit of direct movement of trains into the storage yard, and then into the separating yard as required.

Second—The cars to be held may arrive mixed in with cars that are to go forward. In such cases, the storage yard should be so located in relation to the separating yard that the cars can be moved directly into the storage yard from the separating yard, and then delivered to the classification yard as required.

Third—The character of the freight to be held may be such that it can be put in district and station order at once. In such cases, the storage yard should be located in such relation to the classification and departure yards that cars can readily be moved directly into the storage yard from the classification yard, and then delivered to the departure yard as required.

There are probably other cases, but we have mentioned three of the principal ones to indicate the fact that the location of the storage yard cannot be determined arbitrarily or theoretically, but must be dependent upon the character of the business in each case. The size of the storage yard should be governed almost entirely by the number of cars to be held, and the length of the tracks should be such that a switching engine can readily handle all the cars standing on one track.

POINTS TO BE OBSERVED IN THE LOCATION OF YARD TRACKS.

Having adopted terms and definitions for the various tracks required in yard work, your Committee has taken the further step of laying down certain rules and principles governing the location and use of these tracks.

Body Tracks.—These should be spaced 11 ft. 6 in. to 13 ft. c. to c., and while the minimum spacing is not to be recommended for general use, it is often desirable to use it for the purpose of utilizing the space

in city yards to its fullest capacity. At intervals of five or six tracks an extra width of spacing should be given, in order to allow space for drainage and for the piling of track material, etc. It is also advisable to allow a space of 15 ft. between the center of a main track and a yard track, so as to give ample space for water columns or standpipes, signal-posts, etc.

Ladder Tracks.—Where there are two ladder tracks, or where another yard track parallels a ladder track, these tracks should be 15 ft. c. to c. The extra room is required for the safety of trainmen in throwing switches and moving in and out between the cars. The angle which the ladder track makes with the body tracks should be the greatest angle which the frog used will allow. Your Committee recommends that No. 7 should be the minimum number of frog for yard use. Frogs of higher number are often preferable and are often used, but it must be remembered that the easier curves of such frogs require longer leads and consequently occupy more yard space.

Lead Tracks.—The connection of these tracks with the main line should be controlled by a telegraph office and interlocking plant, both for safety and to facilitate train movements.

Drill Tracks.—These tracks should be so located as to cause a minimum interference with other movements.

Open Tracks.—The track selected as the open track should be one that will enable movements to be made from one end of a yard to the other with the greatest convenience.

Running Tracks.—Tracks of this class should be located with the greatest care. Such tracks should be provided for movement in each direction, to enable yard engines to pass freely from one portion of the cluster to another, also for road and yard engines to go to and from the engine house and other points where facilities are located.

Cross-over Tracks.—These should be located at the most convenient places, and where they will interfere as little as possible with regular movements.

Special Tracks.—In addition to the foregoing, there will be tracks required for special purposes, sufficiently indicated by their names. Several of these have been enumerated in the list of definitions already given, and particulars as to some of them are given below.

Caboose Tracks.—Cabooses arriving at a yard usually return over the same division, instead of going forward. It is, therefore, usually necessary to locate them between the receiving yard and departure yard, and to arrange them so that the cabooses can readily be pushed from a receiving track to the caboose track, and then dropped by gravity on to a train departing in the direction from which the caboose has arrived. There are various ways in which this can be accomplished, but in locating these tracks care should be taken that only a minimum amount of switching will be required. The tracks should be so arranged that cabooses feed forward, first in—first out. Occasionally special tracks may have to be provided for the cabooses of fast freight trains.

Scale Track.—This is usually located between the receiving and separating yards. This is undoubtedly the best location when automatic weighing is adopted, and no reverse movements should be required in taking the cars on and off the scales.

Coaling, Ash-pit, Sand and Engine Tracks.—The engine-coaling facilities are usually located on the track leading to the engine house. Water and sand should also be taken at the same time as the coal, where it is possible to arrange this. The facilities for supplying coal, water and sand are sometimes provided on the outgoing engine house track, as well as on the incoming track. It will be of advantage to provide a run-around track, so that switch engines may clean fires, take coal and water and pass around waiting road engines.

Bad-order Tracks.—These are required in order to get the bad-order cars out of the way of the switching movements, and they should be so arranged as to be easy of access at all times. From them the cars are taken to the repair tracks.

Repair Tracks.—These should be conveniently located, connecting with bad-order tracks, when practicable. They should be laid in pairs, 16 feet c. to c., with space not less than 24 feet between each pair for the handling of material. The length of repair tracks should not, ordinarily, exceed fifteen cars.

Icing Tracks.—These should be located between the receiving and separating yards, so that the cars to be iced may be readily moved from the receiving yard to the icing track, and thence to the separating yard.

Other Special Tracks.—The particular purpose for which such tracks are required should be carefully considered, and the tracks should be so located that their use will involve a minimum amount of switching, and the least possible interference with the regular yard movement.

In presenting this report, your Committee desires to state that it has considered the designing of a yard with reference to the movement of traffic in one direction only. For movements in the opposite direction, a duplication of yard facilities will be required.

Yards should be provided for traffic in each direction. Most of the large yards of the country to-day are made up of only a receiving yard and a separating yard, the trains departing from the tracks of the separating yard. For classification, the cars are switched and then gathered up into a train at the leaving end of the yard. This method of yard work is very common, and is frequently the best that can be provided in most locations. It is, however, an expensive method of operation, with limited capacity, as compared with the results that can be obtained in a properly designed yard.

CONCLUSION.

Your Committee directs attention to the terms and definitions prepared, and submits them for adoption. It has endeavored in this report to lay down the general principles and some of the special require-

ments which must govern yard design. The principles and requirements here given cover the entire series of yard movements (for engines, cars and cabooses) from the entrance of a train into the yard to its departure therefrom. There are many other matters of importance in connection with yard and terminal work, which will receive the future attention of the Committee.

Respectfully submitted,

A. W. SULLIVAN, *Chairman.*
Assistant Second Vice-President Illinois Central Railroad.
J. W. THOMAS, JR.,
General Manager Nashville, Chattanooga & St. Louis Railway.
I. G. RAWN,
General Superintendent Baltimore & Ohio Southwestern Railroad.
E. E. R. TRATMAN, Resident Editor Engineering News.
R. B. TWEEDY, Chief Engineer Wisconsin Central Lines.
S. P. HUTCHINSON, Assistant General Agent Pennsylvania Railroad.
J. B. COX, Chief Engineer Chicago Junction Railway.
C. W. HOTCHKISS, Consulting Engineer.
C. S. SIMS, Engineer Maintenance-of-Way Pennsylvania Lines West.
W. S. KINNEAR, Principal Assistant Engineer Michigan Central Railroad.
J. A. ATWOOD,
Chief Engineer Pittsburg & Lake Erie Railroad, Pittsburg, Pa.

Committee on Yards and Terminals.

Mr. A. W. Sullivan (Illinois Central):—The Committee calls attention of the members to the terms and definitions submitted in its report, upon which it would like to have definite action taken at this meeting. The Committee states at the conclusion of its report that it submits them for adoption. The necessity of this is quite apparent to the members of the Committee, and will probably also be to the members of the Association. We must have terms that have definite meanings, so that when used exactly the same understanding will come to the mind of each person. The Committee has labored with the definitions submitted in its report, and considers them the best that it can offer to the Association in the light that it has had on the subject. I would suggest, Mr. Chairman, that each definition be read and discussed and acted on, as the definitions are the essential part of the Committee's report. The balance of the report is descriptive and not as technical as it will become later on, but it shows the use which is made of the terms and definitions that are offered, and if the Association will either adopt the definitions or show to the Committee that they are not good defini-

tions, which will answer the purpose equally well, it will accomplish as much work as the Committee can hope to do at a single meeting of the Association.

The President:—I presume the Association should act on this report. Of course, the adoption of these terms and definitions by the Association carries with it only the question of our understanding these terms and definitions to mean the things that are described under them for the purposes and uses of this Association. It does not involve the expenditure of any money on the part of the roads we represent, and I assume it would be perfectly within the province of the Association to change a definition; but it would very materially assist in the work of the Committee and aid in our discussions concerning the practice on the different roads if we could agree on uniform terms applicable to the different parts of the subject covered by the investigations of the Committee. The proper motion to be made, in my opinion, would be that the report of the Committee be received, and that the terms and definitions contained therein, as applied to the Committee's work, be adopted. When that motion is put, the criticisms of the various definitions could then be taken up in their order. We could also vote on each definition separately in the order in which they come, which possibly might save time. Has any member a motion to make in connection with this report?

Mr. G. A. Mountain (Canada Atlantic):—I suggest that plans showing the manner of laying out these yards would be a great advantage with this paper. It is very valuable as it is.

Mr. F. T. Hatch (Vandalia Line):—In order to get these definitions before the meeting for discussion, I move the report be adopted.

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis):—I suggest the gentleman amend that so that the report be received and the definitions contained therein be adopted, subject to future amendment if found expedient.

Mr. Hatch:—I accept the amendment. I like the definitions the Committee has given very well except for one word, "cluster." Possibly in course of time we will get used to it and like it. I cannot say I do at the present time. I don't see why "yard" in the plural should not answer all purposes.

The President:—I presume the Committee can give some evidence of the faith that is in them in reference to "cluster."

Mr. Sullivan:—The term "cluster" and its definition is one on which the Committee has been very nearly wrecked on several occasions, and it is offered to the Association as the best term the Committee can suggest for the purpose. There is a necessity for having a term to provide for what is termed "cluster" to represent in our nomenclature that which cannot well be filled by the word "yards," because of the fact that "yards" is a term which has been, and is, and probably will be used so generally and so loosely that it will not have the meaning the Committee desires to attach to this term. In the first place, a yard, reduced to its elements, the Committee finds to be an arrangement of three or more parallel tracks in series for the convenient switching or storage of cars. There is a difference between a series of yards and a cluster. There may be a hundred yards side by side, and still not be a cluster. A cluster is not a plurality of yards. A cluster is an arrangement of yards in series for a definite purpose. It is the series that is the cluster. A series may be three yards or four yards. There may be twelve yards, there may be fifteen yards in a given territory, but a cluster is not a plurality of yards; it is the yards that are so connected together in series as to perform definite functions, and for that function and its physical expression the term "cluster" is the one that has developed itself in the Committee's mind as being the best it could think of for the purpose, and it has concluded, after much discussion and deliberation, to submit it to the Association.

Mr. C. A. Wilson (Cincinnati, Hamilton & Dayton):—The Committee defines the word "cluster" and gives one definition in it, "group," which seems to strike me as being a better word than the word "cluster." The terms which we adopt here will probably pass into current use by the men who are using these yards and terminals. I don't think it will be a very long time till the trainmen would have that word "cluster" shortened to "clus," and if we can get some word of one syllable it strikes me it would be better than a word of two syllables. "Group," being a word of one syllable, would strike me as being a better word than "cluster."

Mr. Sullivan:—I don't think any of these definitions will ever interest trainmen. They don't have to come to the authorities to find names. [Laughter.] The immediate purpose of these definitions is for use in the designing room, not for use in operation, and it is for that purpose that we need a term which is of reasonable conciseness in expression, and the Committee, in confining it to seven letters, thinks that it fulfills the requirements as to terseness, and it is sufficiently expressive to indicate what the arrangement is without the explanation which follows. The Committee has endeavored to find a term which in itself will be something of a symbol and will carry with it the meaning intended. The term "group" has been considered. The Committee has considered every word and everything in the shape of a synonym that could be found in the books, and "group" does not wholly represent the idea. A group is merely an aggregation without any necessary coördination of the parts. It does not follow from that that there is a coördination of parts in a cluster, but there is more likely to be. The function associates itself better with that word than it does with the word "group." The sphere in which these definitions will be used is that of a meeting of this kind, is that of committee-work, is that of the engineer's office, and his instructions and his conversation with his assistants. Beyond that they have not much use, and so far as their being made use of among the men in the yard, that is the most remote purpose they will ever be applied to.

Mr. A. Torrey (Michigan Central):—Does the word "cluster" include the use of the words "eastbound" and "westbound"? Does "cluster" apply to the whole outfit—the eastbound and westbound, if they happen to be side by side?

Mr. Sullivan:—The term "cluster" would apply to each series separately. There would be the westbound cluster or the eastbound cluster, according as there were a sufficient number of yards to form a cluster. The function which tests the cluster is what it does, as is stated, the separation, classification and storage of cars. Classification in this sense includes the making up of trains. That would necessarily require a cluster for one direction, and in the other direction similarly equipped for handling traffic there would be another cluster. Clusters can be assigned for different purposes. They can be assigned to correspond with

districts. For instance, you may have a dock district, which may have its own cluster separate from the cluster for train service, ingoing or outgoing. There is a flexibility in the term sufficient to meet any of the requirements in the service, and the test of the propriety of its use lies in whether it performs the functions, that is, whether it does the work of separating, classifying and storing the cars, and whether the arrangement of the yards of which it is formed is of a series, making of the cluster a working whole.

Mr. H. D. Miles (Michigan Central) :—It seems to me that the word "yard" should not be left off any of the definitions. The Committee has not omitted it in any of the other definitions, nor the word "track" in any of the definitions. The words "combination yard," "series yard" or "marshaling yard" would be better than the word "cluster." There are grape clusters and clusters of other like things, consequently it does not seem to be the term which would exactly convey the meaning that the Committee desires to convey. The terms adopted will be used, not only in the draughting room, but in conversation and in publications, and therefore it is important that there should be no uncertainty as to the meaning to be conveyed by the terms used.

Mr. Wilson:—I have no doubt the chairman of the Committee is much better posted on the definitions of these words, having given the subject a good deal of thought and investigation. Of course, the idea which came to me of the definition of those two words was that "cluster" meant an irregularly arranged group, while the word "group" meant things more in order, and that while the term "cluster" might apply to many of the railway yards in this country, the word "group" would apply better to those as we like to have them. A "cluster" of grapes are grapes arranged in an almost indistinguishable manner, while a "group" of buildings would have some semblance of order in their arrangement. As to what the chairman says about what the men will call them, as we design these yards we name them on the plans, and as our operating officers issue instructions as to their use, they would designate them in those instructions, and as those men who operate them make reports to their superior officers, they will use them, and therefore we should adopt, it seems to me, the simplest words we can use to mean what we wish to say.

Mr. H. G. Prout (Chief Editor Railroad Gazette):—Language is a very hard thing to make. You can't force a word into a language and into general use unless it has an applicability and obvious fitness. The President will remember the effort that was made in the American Society of Civil Engineers for a number of years to have our clock dial graduated from one to twenty-four, and for years our notices went out officially that the meeting would take place at twenty and a half o'clock. With all the intelligence gathered in the American Society of Civil Engineers, I venture to say that ninety-nine men out of a hundred always had to stop and translate that into the common, old-fashioned nomenclature; and so it seems to me with this matter of "cluster." If we adopt this word we shall use it when we are forced to, but with a reservation and with a little smile of deprecation, "Please don't take this seriously. I use it officially." It seems to me that the word "yard" will cover the whole business. Naturally, I don't approach this subject with the consideration that the Committee has given to it at all, but it seems to me that the word "yard" will cover the whole business. That is to say, the yard is the layout that you have at any one place. Then you have your subordinate yards, your receiving yard, your classification yard and your various other yards.

The President:—I do not wish to add anything further to the discord on this question, but Colonel Prout made a suggestion that he probably did not intend to make in his remark—that possibly the use of the simple word "layout" would cover it.

Mr. Prout:—"Layout" would be a good word.

The President:—It seems to me the only way to proceed would be to make a motion to amend it by the substitution of some other word. We can then act upon it and proceed. Is there a motion for the substitution of some other word?

Mr. R. Trimble (Pennsylvania Lines):—I would make the motion that under definitions we eliminate the definition "yard—three or more parallel tracks arranged in series for the convenient switching or storage of cars," and that we substitute for the word "cluster" the word "layout."

The President:—It is moved and seconded that the original motion be amended by the elimination of the word "yards" and the substitution of the word "layout" for "cluster." Are there any remarks on the amendment?

Mr. W. K. McFarlin (Delaware, Lackawanna & Western): —I don't like a "layout." Three tracks would be a layout. It seems to me "series terminal," "series eastbound" or "series westbound" would express it better than layout, and there may be sixteen subyards or more. It is a series. It seems to me the term "series yard" is better.

Mr. Wilson:—My neighbor suggests that the engineer may make a good "layout" of tracks, and two freight trains trying to use them would make a very bad "layout" of a passenger train, which indicates that the use of "layout" might be questionable.

Mr. Hatch:—I move to amend the motion by substituting the word "yards" for "layout."

The President:—The motion before the house now is that the first definition be eliminated and that the word "yards" be substituted for the word "cluster."

Mr. Sullivan:—I wish to say to the Association that these definitions are all related to each other. With reference to the motion as to the word "yards"—"yard" is a unit. It is the elementary principle of the whole scheme of the definition. We must have a yard to start with, and the definition is to find out what is its minimum. We must know what is the minimum status of the word "yard." That is the keynote of the whole series of definitions. I would suggest that in view of the difference of opinion that prevails here, that if the Association is not disposed to adopt this definition, it be referred back to the Committee and not acted upon here definitely, for I can see quite clearly that the motion is impractical and involves it all in a chaos—eliminates the entire element of the whole scheme, and we have nothing to stand upon. The term "yard" is a unit. This definition is the minimum which is the essential requirement of the definition, and the rest of the construction is built upon it. We must remember that or it all falls.

Mr. Torrey:—I move to amend the amendment—to accept all definitions except the one, "cluster." Leave that out.

The President:—And refer that back to the Committee?

Mr. Torrey:—Yes.

Mr. H. F. Baldwin (Chicago & Alton):—I would like the definition of "yards." I do not think we have to have three tracks in order to have a yard. However, if the other question

is to be referred back to the Committee, I would like that definition also to be referred.

The President:—It is necessary to act on this amendment. If the amendment is voted down, then the question of the adoption of the definition could come up for consideration. If the amendment is carried, then the question of the adoption of the definition as offered or amended, comes up. When that question is presented, a suggestion that it be referred back to the Committee for further action will be in order. But the question now before the house is this amendment, which must be voted on either yes or no, or it must be amended. In order to make progress, I will put the amendment, which is that the definition "cluster" be eliminated and the word "yard" substituted therefor.

(A vote was thereupon taken.)

The President:—It is lost. The question now is on the original motion as to the adoption of the definitions. Are there any further remarks?

Mr. F. H. McGuigan (Grand Trunk):—I would like to ask a question. I notice in the definition here, under the head of yards, it reads, "Three or more parallel tracks arranged in a series for the convenient *storage of cars.*" Then again: "Receiving yards, and yards for the reception of *traffic.*" Now, I should like to ask the chairman what the difference is between the commodities stored on the two groups of tracks? Are they not cars in both cases? Why should the word "cars" be used in one paragraph and "traffic" in the other? Then follows "separating yards," in which the traffic is classified. (Quotation from report.) It would seem to me that it would be more proper to use the word "cars" in every instance. As I understand it, the traffic is the commodity that is in the cars. If the car is empty, there is no traffic—certainly no revenue.

Mr. G. W. Kittredge (Cleveland, Cincinnati, Chicago & St. Louis):—I am going to vote "No" on that resolution. I think we have given the Committee something to think about, and I think we should report the whole matter back to them, or leave the matter open. I do not think we should settle at this time all these definitions. Now, to refer once more to the yards—"three or more parallel tracks." We have got a "Gilpin" yard in Cincinnati, and I defy anyone to find one parallel track in that, therefore I

am going to vote "No" on the acceptance of this definition. We can let the Committee continue, allow the definition to carry over until some other time, and I think probably the Committee will give it further consideration, in view of the talk we have had.

Mr. Trimble:—I have heard what Mr. Kittredge has said, and I do not think we have a proper definition of a yard. I do not know that a yard will always contain three or more parallel tracks. There are many cases where there may be three or more, and they may not be parallel, and yet it may be a yard, and I am not sure that it is correct to say there shall not be less than three tracks in a yard, because we call a poling yard a yard, and that might have but two tracks. I intend to vote against the acceptance of the definitions with the view that the matter may be referred back to the Committee.

Mr. D. W. Lum (Southern Railway):—Perhaps it would be well for the Committee to look into what the American Railway Association has done in reference to these matters. I think perhaps they have discussed them, and their influence would be considerable in reference to adopting names after we have passed upon them.

The President:—The situation of the matter now is in regard to the amendment—the motion referring the matter back to the Committee. Has the Committee anything further to say on the subject?

Mr. Sullivan:—I think it is quite apparent that there is no general understanding of what a yard is. Now, if we think two tracks can constitute a yard, we simply don't understand the proposition. It is physically impossible to make a yard out of two tracks. Furthermore, the Committee considered it was necessary to make a distinction between a set of passing tracks on a line and a yard on a main line. It is now a pretty well-established custom to have passing tracks in duplicate at meeting points. Two of such tracks would be in no sense a yard; two such tracks could not be made to serve the purpose of a yard; but when you have an arrangement of three tracks, then you can begin to develop the function of a yard, and as you add to the tracks, the skillful manner in which they are arranged in series will increase those functions very largely.

So far as the term "cluster" is concerned, I would say that the Committee agreed not to recommend a compound word. No compound word is satisfactory as a term; it must be some simple word—the shorter the better. So far as this definition being in conflict with anything any other association might do, or so far as the American Railway Association is concerned, I would state that the American Railway Association has no committee which can take up a question of this kind. This is the first organization—the first association, to organize for this purpose, and the functions of this Committee require it to arrange these terms and definitions. If this Association adopts those terms and definitions, they become official.

The President:—The Association could do either of two things. These definitions could be adopted, and if in future it was deemed desirable to amend them, this could be done from time to time; or the report can be received and the recommendation referred back to the Committee for further consideration.

The question now before the members is on the reception of the report and the adoption of the recommendation of the Committee.

Mr. D. D. Carothers (Baltimore & Ohio Southwestern):—On account of the chaotic condition of the matter, it seems to me it would be well to refer this back to the Committee, and I therefore offer a motion that it be referred back to the Committee to be reported upon at another meeting.

The President:—Mr. Hatch, if you will consent to Mr. Carothers' amendment it will save time—that is, to amend your original motion that the report be received and that the recommendation as to the definitions be referred back to the Committee for further consideration.

Mr. Hatch:—I accept that.

(The question being put, the motion prevailed.)

The President:—Is there any further discussion on the general question of the report of the Committee?

Mr. W. McNab (Grand Trunk):—In regard to terminals, and more particularly freight terminals, if I remember aright, last year there was a good suggestion made by one of the Board of Direction in regard to short parallel tracks in pairs running out from the main track as nearly at right angles as

possible, that would permit the handling of about ten cars on each track, and a tramway between each pair, as against the too common custom of a long track and a long tramway beside it, which results very frequently in a block of cars at inopportune times, besides other inconveniences. I would ask if the Committee has taken into account this proposition, which was suggested last year, as to tracks for the quick receipt and delivery of freight in bulk.

Mr. Sullivan:—The Committee is dealing with this question in its elementary form. It has not submitted any diagram with this report because the time for diagrams has not yet come. The arrangement of tracks is a matter which the Committee will consider in its future work, but it has submitted here in this report as much material as it could prepare for the consideration of the Association during the interval since the last meeting. It is the understanding of the Committee that this work will go on for a number of years. It will evidently take quite a long time to complete its work, and it hopes gradually to build up a structure that will include every form of activity that is necessary and essential to the operation of a terminal. With reference to the term "terminal—the facilities provided by a railway for the conduct of its business at the end of its line, or of a division or a district," it is the understanding of the Committee that the term "terminal" includes everything, not only the tracks but the structures and the wharves, if there are wharves, and all the buildings that may exist upon the terminal, the use of all the structures. The Committee will not deal with the structures themselves, but with their uses in the operation of the terminal.

Mr. McDonald:—The Committee has announced that in order to carry out its scheme it must have certain terms understood, and I think it is our duty, whether we accept those terms or not, to at least allow it the privilege of using them until we get something better, and I therefore move we adopt these terms as it has suggested them, reserving the right to amend them in the future. It occurs to me as long as they have expressed a desire to use these terms in their communication we might at least allow them that privilege, and when they report next time they will present the plans, and if we want to change a word we can do so.

The President:—Is there a second to that motion? This is the old question in a new form. It is practically a reconsideration, and I presume it could be declared out of order on that ground, but we want the matter thoroughly discussed. Those who have read the report will agree that the Committee has done some real work in getting at the matter in the right way. Their work in this matter is necessarily difficult, and of course should be encouraged as much as possible, particularly as the Committee has given the matter consideration, and we have not. I will therefore decide that the motion is in order. Are there any remarks on it?

Mr. Carothers:—My object in putting the motion that I did —that this be referred back to the Committee—was not but that I thought the work had been honestly and well done by the Committee, but merely for the reason that it seemed to be in such a chaotic state in the discussion here that it did not look as if we could reconcile, and the members not having had time to give it the consideration that the Committee has given it, as has been stated, it would seem to me to be wiser to allow it to go over until another meeting, and that is the only reason. It should be the duty of the members in the meantime to put their objections on paper, so the Committee can have them when we come to another meeting, and the members will be as well posted then as the Committee is, and have an opportunity to study it, and that is why I make this suggestion.

The President:—There are practically only two criticisms on the report, and those only on two definitions. If the definitions were adopted temporarily, and amended at the next meeting if found desirable, it would encourage the Committee.

Mr. Prout:—I think I see a gleam of triumph in the eye of the chairman in having reached this point, and I would suggest that this body ought to insist that the Committee present its diagrams before we adopt its definitions.

Mr. Sullivan:—The Committee is not able to submit a diagram until its definitions have been approved, so it can indicate what it is submitting. [Laughter.]

Mr. Trimble:—The Committee has done good work, and in opposing the definitions I do not intend to be derogatory of the work done, but I feel there are more people here who look upon

these definitions with some suspicion, and if a "yard" is to be three tracks and nothing less, a departure yard is to be not less than three parallel tracks, and a receiving yard not less than three parallel tracks, I think we will want some more definitions. It seems to me that there are a great many yards which start with but two departing tracks, which are to do business, and possibly only two receiving tracks. According to the definition of the Committee that would not be a departure yard, but departure tracks. At the same time we might have two receiving tracks and it would not be a receiving yard, and there are possibly more definitions than the ones discussed, namely, "yard" and "cluster," that might want revision.

Mr. Sullivan:—There has been no discussion or criticism of the definitions at this meeting which has not already previously taken place in the Committee. The Committee has considered all the phases of the question which have been here discussed by the members, and some others which the members have not yet thought of. [Laughter.] As a result of its deliberations and discussions, extending through eight or nine meetings during the past year, these are presented as the best definitions which it can submit. Now, whether these definitions are liked by the members is not the thing. That is not the real test of the question. The only test is whether the definitions fit the functions first, and then whether the language correctly conveys the meaning. The Committee has considered both phases of the proposition—that the definitions fit the functions closely, and that the language which has been carefully culled expresses precisely the meaning which the Committee desires to have in the definitions.

The President:—I will put the motion, which is on the adoption of these definitions. All in favor of their adoption will signify by saying aye, contrary no.

Mr. McDonald:—I would suggest that the motion was not put as made. The motion was that we adopt them with the privilege of amending them in the future.

The President:—That goes with it. I stand corrected. The motion is that we adopt the definitions with the privilege of amending them at some future meeting, if we desire to do so.

(Whereupon the motion was put to the Association.)

The President:—The motion is carried and the definitions adopted. Is there any further discussion of the report as a whole? If not, the Committee will be excused.

The next is the Committee on Ballasting. The Committee will please come forward.

REPORT OF COMMITTEE NO. 2—BALLASTING.

To the President and Members of the American Railway Engineering and Maintenance-of-Way Association:

Your Committee is, unfortunately, obliged to come before you with an apology instead of a report. Two very able chairmen have been obliged to resign since the last meeting—Mr. Montfort, on account of ill health, and Mr. Peddle, because of added duties which prevented him from giving the necessary attention to committee-work. As Mr. Peddle was vice-chairman while Mr. Montfort was chairman, the two resignations left the Committee without a head and with no one sufficiently conversant with what had been done to take up the work and complete it. The Committee was not reorganized until about the first of February, and it was then too late to gather and compile the necessary information for a complete report at this meeting, and we can only make a progress report, defining the fifth subdivision, "What Constitutes Ballasted Track," and telling you what we hope to do before the next meeting. The work before this Committee was so ably outlined at the meeting a year ago that we think it only necessary to assure you that we will do all we can, with the help of the Association, to make a report so full and complete that it will be used by the Maintenance-of-Way officials as a practical work on ballasting.

Before passing to the consideration of what constitutes ballasted track, your Committee believes it will be well to say something to the Association about the importance of ballasting and the great lack of published information in regard to it; this lack, however, it hopes will not be so great when this report is completed. We do this hoping it will arouse railroad men to a greater interest in the subject and that it will stir up a full and free discussion, eliciting much valuable information from the members of the Association.

It is the opinion of your Committee that ballasting is one of the most important factors in the safe and economical maintenance of railroads and that there is less known about it and less attention given it than is the case with almost any other branch of Maintenance-of-Way and Structures. Books galore have been written about rails, cross-ties and other track material, about bridges and other railroad structures, and many able engineers have told us how to locate and build our railroads, how to make the cuts, construct the embankments, take care of the drainage, etc., but when it comes to ballasting, they dispose of the whole matter by saying, "The track should have plenty of good ballast to hold

it in place and provide for drainage." Very meager information, it seems to your Committee.

The International Railway Congress at Paris, last year, brought forth some good information on this subject, the report of Mr. Feldpauche being especially interesting. A paper written by Director Shubert of the German Railways, on some extensive and comprehensive experiments and observations made by him, is particularly valuable. We hope to give the Association the benefit of this information as the report progresses.

That ballasting is of great importance, when considered from an economical standpoint, can be readily shown by a few figures taken from the report of the Interstate Commerce Commission for 1899.

In 1899, $522,967,896.00 was paid out in wages to the officers and employes of the railroads in the United States. Of this amount, $79,264,280.00, or a little more than 15 per cent, was paid to trackmen alone. Assuming (and the assumption is not far wrong) that 40 per cent. of this amount was paid for lining and surfacing, you have the immense sum of nearly $32,000,000.00 paid out for labor in keeping up the line and surface. The total expenditures on account of Maintenance-of-Way and Structures in 1899 amounted to $169,825,054.00, or about $902.00 per mile of road. Of this, $32,000,000.00, or $168.00 per mile of road (or 19 per cent. of the total Maintenance-of-Way and Structure expenditures), was on account of line and surface. When we consider how much of this great outlay was probably due to inadequate ballast, we feel that the subject is well worth careful and exhaustive study and we trust to receive the hearty and generous support of the Association in our efforts to make a report that will be of some practical value.

WHAT CONSTITUTES BALLASTED TRACK?

To answer this, two things must be determined: 1. What is ballast, and what are its functions? 2. How much of it must there be?

1. What is ballast, and what are its functions?

The third definition given by the Century Dictionary is: "Gravel, broken stones, slag, or similar material, placed between the sleepers or ties of a railroad to prevent them from shifting, and generally to give solidity to the road."

The third definition in Webster's International Dictionary says: "Gravel, broken stone, etc., laid in the bed of a railroad to make it firm and solid."

Webster also gives a figurative definition, which seems to apply with peculiar fitness to railroad ballast: "That which gives or helps to maintain uprightness, steadiness and security."

Rankin says: "Ballast is that portion of the permanent way of a railway which forms a firm and dry foundation for the rails or for the sleepers by which they are supported."

Mr. Feldpauche, Principal Assistant Engineer Pennsylvania Railroad, in his report made to the International Railway Congress, says: "By way of introduction, it would seem appropriate to assert that good ballast should consist of such materials as would best insure a substantial, enduring, dustless and somewhat elastic foundation for the track. It should be substantial, so as to distribute the strain of passing loads upon the largest possible area over the underlying roadbed, thereby reducing to a minimum the depressing tendency of ties. It should be enduring, so as to lessen, as much as possible, its destruction from tamping and the expense thereby entailed for its renewal. * * * It should be dustless, so as not to discomfort the passengers or heat the frictional parts of the running equipment. Finally, the ballast should be somewhat elastic, so as to lessen the shocks and thereby reduce the wear and tear upon rails and trains."

Mr. Bauchal, Assistant Permanent Way Engineer of the French Western Railway, in his report to the Congress, defines the functions of ballast thus:

First—"It gives the track a suitable support and fills up inequalities in the formation level.

Second—"It distributes the pressure upon the formation level and reduces the pressure per unit of area.

Third—"It acts as an elastic support to the track.

Fourth—"It resists the lateral displacement of the track, both through its mass and through friction.

Fifth—"It resists longitudinal displacement of the track.

Sixth—"In case of certain formation levels, it acts as a protection against frost.

Seventh—"It protects the wood (presumably of the ties) against excessive dryness or excessive dampness."

Our own chairman, in his report to the Association a year ago, said: "Ballast may be defined as the material above the roadbed, in which the cross-ties are imbedded, and its object is to get a solid and uniform bearing for the cross-ties, to distribute the applied load over a large surface of the roadbed, to hold the cross-ties firmly in position, to give elasticity to the track and to allow the water to pass off freely, thus avoiding churning in wet weather and heaving by frost."

You will notice that none of the foregoing descriptions of ballast and its functions, except that of our former chairman, say anything about drainage, which we believe to be one of its most important functions. There is one word used in all these definitions that we do not think to be well chosen. That is "elastic." Elastic means something springy, and we certainly do not want that in our track. The condition desired is that it shall not be rigid or unyielding, but shall be to some extent flexible or pliable; we believe "pliable" more nearly describes the condition we desire, and will use that word hereafter instead of elastic.

Your Committee will not, at this time, attempt to describe an ideal ballast, but simply what the materials must be and do to fulfill the primary requirements.

To be ballast, it must be substantial, so as to distribute the applied load; it must be enduring, to resist as far as possible destruction from tamping; it must be pliable, to diminish the shock and consequent wear of track and trains and permit of easy manipulation in lining and surfacing; and it must, above all things, provide thorough drainage.

Earth or dirt will fulfill none of the above requirements, and we do not think it should be designated ballast; we consider earth or dirt ballast to be a misnomer, and that track put up with it be called earth or dirt track. There is another material, used somewhat extensively in the South for ballast, with which your Committee is not familiar; that is, chert; we know it is a variety of stone, but do not know enough about it at the present time to be able to say that it makes good ballast. Sand, we know, will, with proper care and attention, make a good track, but it is easily washed out by even moderately heavy rains, it is blown away by high winds, and intolerably dusty, and causes more or less trouble from hot boxes and an appreciable wear of rails and rolling equipment. There may be materials unknown to your Committee that, in some localities and under some conditions, can be satisfactorily used, but so far as we are now prepared to schedule them, the materials which we know will satisfy the requirements of ballast are broken stone, gravel, burnt clay, cinder, burnt shale and chatts. The requirements as to quality, size, etc., and the comparative merits of the various materials will be considered later in this report.

Now that, to a certain extent at least, we have decided what materials will make ballast, it remains to determine in a general way, what shall constitute ballasted track.

The functions of ballast are: To make a solid and uniform bearing for the cross-ties; to distribute the applied load over a large surface of the roadbed; to hold the cross-ties firmly in position and to provide drainage.

In the report of this Committee, read at the first Annual Convention, our chairman said, "Full ballasted track does not mean the same on all lines. It is largely dependent upon climatic conditions, character of material composing the roadbed, weight of rolling stock, the daily number of trains and their character—whether passenger or freight. * * *"

Your Committee fully appreciates all this and realizes that it cannot arbitrarily lay down a hard and fast specification for ballasted track, and must, therefore, make its report in very general terms.

However limited may be our knowledge of ballasting and however much the conditions may vary as to climate, traffic, etc., there are some things we all know, and these must be borne in mind in connection with ballasted track. We know that an inch or two of ballast under the ties and none between them will fulfill none of the functions; we know that an inch or two under the ties, with the track filled in, will neither dis-

tribute the applied load over a large surface of the roadbed or provide thorough drainage or permit of proper surfacing or tamping, and we know that no amount of ballast under the ties, with none between them, will hold the ties firmly in position or make a safe and secure track.

Your Committee would particularly call your attention to the fact that a sufficient amount of the proper material is not all that is necessary in ballasted track, there must also be a suitable ballast cross-section, but this will be considered under "Standard Cross-sections."

To summarize, then, your Committee would report as follows on "What Constitutes Ballasted Track:"

The materials used must be substantial, able to distribute the applied load over a large surface of the roadbed; they must be enduring, to resist, so far as possible, destruction from tamping and disintegration from age and weather; they must be of such character as will allow easy manipulation in lining and surfacing and furnish proper drainage. In quantity, there must be a depth under the ties sufficient to transmit the applied load over a large surface of the roadbed and to provide a firm and uniform bearing for the ties, and to furnish thorough drainage. There must also be enough to fill in the track and construct the standard cross-section, so as to hold the track firmly and securely in position and aid in the drainage.

Respectfully submitted,

F. T. HATCH, *Chairman,* Vandalia Line;
F. A. MOLITOR, *Vice-Chairman,* Choctaw, Oklahoma & Gulf Railroad;
J. T. RICHARDS, Pennsylvania Railroad;
H. U. WALLACE, Illinois Central Railroad;
A. MORDECAI, Erie Railroad;
EDWARD SHELAH, Philadelphia & Reading Railroad;

Committee.

The President:—We all have a copy of the report and we will therefore call on Chairman Hatch for any remarks he desires to make in connection with it.

Mr. F. T. Hatch (Vandalia Line):—I dislike to make any report at this time, because I have not even had a chance to get acquainted with the members of this Committee. We have never had a meeting. The Committee was not organized until about the first of February, and I am not acquainted with a single member of it, and have had to do all the committee-work from correspondence. After the report was sent to the Secretary, and I got the views of the other members of the Committee by correspondence, I found there was considerable objection to the latter part of the report, and I think these objections as a rule were well taken. They were to the effect that we should not in this pre-

liminary report designate what is proper ballasting of track; that we should not be too specific; that we should not say how much ballast should be under the ties or exactly what material the ballast should be composed of. The chairman of the Committee in going over the matter concluded that the amount of ballast, etc., would come up under the head of "standard cross-sections" later, and it was perhaps better not to be too definite in this report. To meet the views of the other members of the Committee the latter part of the report has been rewritten.

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis):—The Committee has confined its report entirely to the question, "What constitutes ballasted track?" I remember when this matter was under discussion in the Board of Direction that I suggested that question. My object in suggesting it was that we might be able to answer the many questions that are put to us as to how many miles of ballasted track we have. My observation has been that track does not always remain ballasted, and I would like to have the question determined as to when track may be considered ballasted. Whatever the cross-section that may be adopted as standard by this Association, if track is maintained in accordance with that cross-section, it may be considered ballasted track; but track that has become foul and filled with dirt, although having been once ballasted, can no longer be considered ballasted track. I have known roads that have once been ballasted thoroughly, and at the end of twenty years they have nothing that might properly be designated as a ballasted track.

Mr. G. A. Mountain (Canada Atlantic):—I would ask the Committee, in considering the ballasting of a track, whether the formation of the ballast bed should come up with the tops of the ties at the end. That might properly come under the head of drainage, but I ask the question just the same.

Mr. Hatch:—My idea is that properly applies to standard cross-section. We hope to submit a proposed standard cross-section which will show where the ballast properly should come, and we did not put it into this incomplete definition of what consitutes ballasted track. It might be well to say something in this report how old foul and worn-out ballast should be before it would be considered as not constituting ballast. That, though, is a very difficult question to decide.

Mr. D. MacPherson (Canadian Pacific) :—In the report it is stated that "the functions of ballast are to make a solid yet pliable and uniform bearing for the cross-ties . . ." It seems to me that the word "solid" is too strong, and that "firm" would be a better one.

Mr. Hatch :—We ought to get as far as possible away from the idea of having elasticity in our track. If everything was perfect, the best thing we could have would be masonry. We should have very nearly a perfect form of construction if we could lay rails on masonry. As long as we cannot have that, we must have a certain amount of adaptability in our track to handle and take up the shocks incident to our imperfect roadbed.

Mr. MacPherson :—Does not "solid" mean "rigid"?

Mr. Hatch :—I do not think so, altogether. There may be a similarity between the words, but I do not think "solid" conveys exactly the same idea as "rigid."

Mr. MacPherson :—I cannot agree with the remarks of the chairman that the nearer we get to solid masonry bearings the better, as I have frequently noticed that rail joints batter down much more quickly in rock cuttings, where there is but little ballast, than elsewhere.

Mr. D. W. Lum (Southern Railway) :—I think Mr. McDonald has struck the keynote with reference to the matter of ballasting track. I think we all recognize the fact that a great deal of rock is frequently put on the road, and still it is not ballasted, and perhaps that is due very largely to the fact that while we have a mass of rock under the ties, and it is very solid and supports a portion of the ties, there are others in that same panel which may be loose and swinging, and that makes the hardest riding track we can imagine. We have on the Memphis division a material such as is referred to in the report, called "chert." There is a bank of about 150 acres, about 75 or 80 feet high, and that material is used as a ballast very successfully. It costs twelve or fifteen cents to load and has been hauled to Memphis and used in some of the suburban streets instead of paving, and has also been used in the country roads and turnpikes. We have about 250 or 260 miles of track ballasted with this material, and it becomes very hard indeed after it has remained in position any length of time, and if in putting it in it is carefully

tamped and the chert is properly packed in under the ties, and tamped with tamping picks under the rails, it makes a perfectly hard and smooth track; but if there is any neglect and the joints are left without proper tamping it becomes very rough; because chert cements and becomes one solid mass under the tie.

Mr. F. B. Harriman (Illinois Central) :—It seems to me that this Committee should have determined upon some definitions of the matters involved in their report. They say what shall constitute ballast, but do not describe it, and it appears to me that while all the substances mentioned here can properly come under the head of ballast, it is the function of the Committee to have decided what particular size of stone, for instance, was ballast.

Mr. Hatch:—I would say that that was a specific part of the Committee's work—what size of stone should be used. We will try to answer this question under another head, under the head outlined by the Board of Directors.

Mr. W. G. Besler (Philadelphia & Reading) :—In view of the explanation made by the Committee I believe we can afford to accept this report as a report of progress, and allow them at a future meeting to give us the benefit of a little better report, or a little more of it. I move, therefore, that this report be accepted by the Association.

The President:—It is understood that all of these reports are progress reports. While we receive the reports, we do not discharge the committees, but expect to continue them indefinitely. It is moved and seconded that the report be received as a progress report.

(The motion was then put to the Association.)

The President:—The report is received. If there is no further discussion on it, the Committee will be excused.

The next in order is the report of the Committee on Masonry.

REPORT OF COMMITTEE ON MASONRY.

To the American Railway Engineering and Maintenance-of-Way Association:

The subject of masonry, as outlined by this Committee at the previous convention, embraces the materials used in stone, brick or concrete structures, built for carrying the roadbed and tracks of modern railways and structures incident thereto; their design, and the best practice of

the present time for securing convenient, economical and durable construction.

The term "masonry" will be used to apply to any material laid in mortar—which is the original meaning, but not the present one. A modern dictionary defines it as a "construction of dressed or fitted stones and mortar, as distinguished from brick or 'brick masonry.'" The "art," with which we have nothing to do, is applicable to either brick or stone. Rankin divides "masonry" into "stone masonry" and "brickwork," and uses the word masonry in connection with stonework only; the same is true of other writers. In the older parts of this country stone laid up without mortar is also termed "masonry." Paving and riprap are not masonry.

It is recommended, however, in order to avoid misunderstanding, to qualify the word when used, particularly in specifications or descriptions where clearness is imperative. In railroad work, "masonry" has undoubtedly, up to the present time, meant stonework only, but hereafter the definition should include brick and concrete work.

In approaching the consideration of this subject the Committee finds a lack of statistical and historical information from which valuable and important deductions might be drawn; the various kinds of stone used in different localities are but in few cases referred to their geological position, making it difficult to trace the different materials of construction to a common origin, from which record their qualities might be partially known in a new field.

In the consideration of the subject, your Committee has endeavored to separate it upon the following basis:

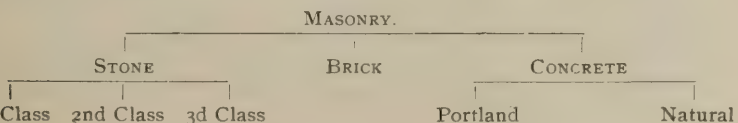
1. CLASSIFICATION OF THE DIFFERENT KINDS OF MASONRY.

2. THE MATERIALS OF CONSTRUCTION.

3. THE ECONOMIC CONSIDERATION.

4. THE DESIGN, INCLUDING FOUNDATIONS AND DETAILED SPECIFICATIONS.

(1.) In the works of reference bearing upon stone masonry, and especially as between English and American practice, there is a wide diversity as to the class of work intended by different terms; notably, the English definition of rubble calls in some instances for a class of work which an American engineer would designate range work or second-class masonry. The possible difficulties liable to arise from such confusion of names has led your Committee to recommend the following classification and subdivision of terms:



While the actual specifications for these subdivisions will eventually be considered in the fourth division of this report, the general difference will be stated here for the sake of clearness in discussion.

First-Class Masonry will include all cut stone work, ordinarily coming under the head of arch and ashlar work.

Second-Class Masonry will include all range work, where stones have parallel top and bottom bed dressed to size and laid either in parallel or broken range.

Third-Class Masonry will include all work laid up without regard to range or bed, where stones are shaped to fit entirely with the hammer and where spalls and chips are permissible to secure a bed.

Subdivisions of these three classes may be necessary, but they would be met by specifications and drawings.

Brick Masonry will include all classes of brickwork, whether vitrified, paving, pressed, or common brick.

Concrete will include all monolithic work, composed of broken stone, or gravel, singly or combined, and laid up with a matrix of cementing material.

(2.) THE MATERIALS OF CONSTRUCTION, their characteristics, qualities, distribution and availability, form one of the most important features considered, influencing as they do the class of masonry which the constructing engineer is obliged to adopt.

THE MATERIALS are stone, gravel, brick, sand, hydraulic cement, asphalt cement and lime.

STONE being the natural product, of wide distribution throughout the country, and the type of construction most generally used in permanent works in the past, we will consider it first. While the number of geological varieties of stone suitable for masonry is few, their variation in quality and characteristics is very great. From 63 railroads reporting, we find materials used as follows:

TABLE NO. 1.

	For Stone Masonry.	For Concrete Masonry.
Brick	12	..
Freestone	3	1
Gneiss	1	..
Granite	16	5
Gravel (singly or with broken stone)	..	31
Lava	2	..
Limestone	34	39
Sandstone	35	15
Slag	..	1
Tailings	..	1
Trap	..	4

No stone masonry, 9.
No concrete masonry, 6.

It is notable in these reports that some railroads using sandstone for stone masonry use limestone for concrete masonry, but give no reason for the exclusion of sandstone from the concrete.

Stonework has in the past been pre-eminent in railroad work, but the conditions are now modified by the successful and cheap manufacture of vitrified brick and Portland cement, permitting their extended adoption in permanent structures in localities where the absence of suitable stone makes its cost excessive and prohibitory.

Stone for railroad work has been the most common, and generally the cheapest and most available material. The present time finds each railroad supplied with a knowledge of the variety and quality of stone at its disposal, and its choice is limited by economic reasons. The primary requisite is cheapness, and a comparative estimate with other available material quickly decides whether it may or may not be used.

Durability is the second requisite. Selection is made from material having a good record, and laboratory tests are seldom necessary for ascertaining merits or defects. Composition, texture, hardness, strength and structure are attributes of durability. Appearance, as far as the generality of railroad structures is concerned, is of minor importance. Stone fails from both mechanical and chemical action, and when placed at the water line suffers most seriously from these two causes. Uniform temperature above freezing with dry atmosphere is conducive to durability. A moist climate, with extreme summers and winters, is the most destructive. Changes of temperature cause unequal expansion and contraction in the different constituents of a stone and thus bring about incipient cracks, which may lead to final disintegration. Granites are principally affected in this way. The freezing and thawing of water contained in a porous stone is an agent whose disintegrating effect is very rapid. Sandstones or porous limestones suffer principally from this cause.

Since all rock, as it lies in the quarry bed, is more or less saturated with water, a freshly-quarried rock should never be exposed to the action of the frost, as in extreme cases it may burst the stone, or even if no visible injury is done, it is certain to weaken the stone and to shorten its life. All stone should be allowed to season or thoroughly dry out before being placed where, from its position, it may never have a chance to do so. The hardening effect observed to take place by seasoning is probably due to the fact that the water in the stone contains silica or other cementing matter in solution, which is deposited as the water dries out, and thus consolidates and strengthens the rock.

The solvent action of rain, especially in an atmosphere laden to any extent with carbonic acid or sulphurous gases, is a destructive influence, felt principally by many of the limestones or marbles, as it dissolves the calcite or tremolite, leaving the surface roughened, and grains of the harder particles of rock free to be washed away.

Rocks which contain the iron salts may suffer by the oxidation of these constituents, sometimes by only change of color, in others disintegration more or less complete.

The selection of a stone for any definite building purpose is an important matter, to which too little attention has been paid in the past.

In determining its value, observation of the stone as found in the quarry is perhaps one of the best methods of judging of its lasting qualities. The comparison of the freshly-cut surfaces with the natural outcrop which has undergone prolonged weathering affords a criterion that cannot be had elsewhere.

Observation of buildings and tombstones made of the stone under examination may often give valuable information and be of great aid, but this is liable to be obscured to more or less extent by unknown factors, such as improper quarrying, injury of the stone by blasting, rough handling, etc. Local atmospheric conditions again may be entirely different from those to which it is proposed to subject the stone. For these reasons it may be well to supplement the above observations by certain laboratory tests.

The size of the pores in a rock is a matter of considerable importance. If they are of such size as to allow of rapid evaporation, or to allow such water as may be left in the rock to be extruded on freezing—in other words, if there be room enough for the water to expand—freezing and thawing are not likely to have a very deleterious effect. An example of this is seen in the soft bricks at one time so much used for paving sidewalks.

If the pores are so small that evaporation is difficult, and there is no room for the water that may be in the stone to expand, while the rock is less susceptible of saturation, in case it does become so by prolonged wetting, the effect of a subsequent freezing may be very destructive. Sandstones, if free from laminations of varying porosity, may be very little affected by freezing and thawing. The destructive action often noticed in the Connecticut brownstone is due to the fact that a porous layer may lie near the surface, and, being protected from rapid evaporation by a less porous one outside, it is still full of water when the freezing takes place and pushes off the outer layer. An action similar to this occurs in many limestones, and particularly those of a laminated structure.

The essential qualities of a good building stone may, then, in a general way, be said to be a homogeneous and compact texture, a grain not too coarse and constituents or cementing material not readily soluble. It should show a clean fracture and give a clear ringing sound when struck, and, finally, in order that it may not be too expensive, it should be capable of being easily worked.

Brick Masonry appears to be used but sparingly, principally probably, in end walls to pipe culverts, city abutments, arch rings and tunnel linings.

The principal requisite in a good brick is thorough burning, even to the point of vitrification, but too much vitrification has a tendency to reduce the adhesion between the brick and the mortar, but your Committee suggests that, with more complete experimental data, the degree of vitrification allowable may be indicated by the absorptive power

of the brick, making a simple and effective method of testing the quality.

Brick can be obtained of sufficient compressive strength for ordinary work, it is convenient and economical in handling and under proper specifications and inspection, with due regard to the quality of the mortar, can be laid up into masonry which will compare favorably with much of the stone masonry in use at present.

In all classes of masonry, and more especially in concrete masonry, the quality of the *sand* is of the utmost importance. The combination of the sand with lime or cement is a chemical and not solely a mechanical one; therefore all sand should be silica and not limestone sand; there can be no chemical combination between lime and limestone sand, but with lime and silica or quartz sand there is gradually formed an insoluable silicate of lime, insuring permanence in the bond of the masonry.

Concrete. We come now to the consideration of a class of masonry, the usefulness and adaptability of which to the purposes of the constructor are becoming more fully appreciated continually; its application is almost universal, enabling permanent structures to be built where, for the lack of suitable material, stone masonry is impracticable.

In this subdivision of the subject, statistical information is almost entirely lacking, except such as may be taken from text-books. The features to be considered can be briefly stated as follows:

1. *Proportion of Ingredients.*
2. *Kinds of Material Suitable for Its Composition.*
3. *Total Volume of constituent Material to Produce One Cubic Yard of Concrete in Place.*
4. *Relative Value of Portland and Natural Cements.*
5. *Expansion and Contraction.*
6. *Ultimate Compressive Strength.*
7. *Resistance to the Action of Frost.*
8. *Resistance to the Impact of Ice and Drift.*
9. *Class of Work to Which It Can Be Applied.*
10. *Methods of Construction.*

And in these features your Committee finds itself almost entirely without new or tabulated information.

A comparison of the reports indicates a tendency to increase the strength of the matrix and reduce its volume by the addition of gravel and the use of unscreened stone to assist in filling the voids in the material mass; the stated proportions varying from 1, 2 and 4 to 1, 3 and 6, with gravel added in most cases, but volume not stated; a few report the use of gravel alone without the use of broken stone.

Table No. 1 shows that limestone and sandstone are most generally used, probably on account of the cheapness of crushing, but several lines exclude the use of sandstone from concrete masonry, although using it principally or exclusively for stone masonry; no reason is assigned for this, and your Committee suggests that it may be due to local conditions

entirely and not to any unsuitable characteristics of sandstone for the purpose.

We find the largest size to which stone is allowed to be crushed to be 2½ inches, with the preponderance strongly in favor of 2 inches. No information has been received relative to the use of "one-man" stone, or rubble blocks in the mass of pier masonry, as an element of economy, but such use is quite usual, and we believe it to be permissible under proper restrictions and supervision.

The only data available showing the volume of constituents are contained in the various text-books upon the subject and we have therefore withheld any discussion upon this subject at the present time.

With respect to the relative values of Portland and natural cement, the preponderance of opinion is that Portland should be used for all important structures exposed to the weather, and that the use of natural cement should be confined to interior work and dry foundations. The use of the two cements adjoining in the same work is of questionable propriety, but in the absence of actual information we are not prepared to condemn it at present.

The expansion and contraction of large masses of concrete, with resulting cracks in the final setting, introduces a factor requiring careful attention in the construction of long walls and large piers, but this being a matter of design, it will be treated in the division upon that subject.

The resistance to the action of frost and to the impact of ice and drift appears not to be so serious as has formerly been supposed; examples of excellent and durable work in our colder climates are not wanting, and work put up in zero weather affords ample indication that with proper care and precaution concrete masonry can be constructed at a season of the year when it would be unwise to attempt stone or brick masonry. We would especially emphasize the necessity of heating the stone as well as the sand before mixing in very cold temperatures.

The advantages of concrete masonry cover a wide field; the cost of transportation of the constituent material is lower than the mass of other classes of masonry; it is economically handled at the site of the work, and there is no waste material unsuitable for use at other points. Skilled labor is not a requisite, and much of the ordinary labor may be substituted by machine mixing where the volume of the work will warrant. It is, perhaps, the cheapest and most satisfactory method of repairs and enlargement of old structures, and for increasing the strength of arches is of the utmost value. It is of interest to note that in the eastern and middle states, where first-class masonry stone is universally obtainable, that the concrete form is gradually taking its place, almost as universally as in the Mississippi Valley states, where quarries suitable for stone masonry are rare.

The methods of construction will be treated under the division of design.

(3.) We now enter upon an important feature of the subject which has never been thoroughly treated, but which presents questions of im-

portance involving both physical and financial conditions. The engineer is met in the first instance with the TYPE OF CONSTRUCTION which he should recommend for adoption, and into this question enters the volume of traffic, the materials at hand and the probable permanency of the structure.

In new railroad construction, especially in undeveloped fields, permanent masonry work is rarely advisable, except at large bridges and city terminals, for the reason that almost all lines are subject to revision as the traffic increases, requiring an investment of capital not warranted at the time of its projection.

Again the meaning of permanent work is of doubtful significance. It is questioned by some of the correspondents whether steel structures should be considered permanent, and in view of the fact that the majority of the steel bridges constructed from fifteen to twenty years ago are now being replaced, the question is worthy of consideration; but the same query will apply to the masonry work, where in the West the masonry of twenty years ago, with the exception of most important structures, is now being either torn out and replaced or enlarged and strengthened with concrete.

It is rarely that architectural considerations should weigh against economic ones in the selection of a type of structure or materials of construction in railroad work, and then only to some extent in densely populated districts and cities.

Financial Conditions may justify the least expenditure at the present time, regardless of the fact that it may be the most expensive in a long term of years. On a line with light traffic, temporary structures are permissible, as future conditions may cause the line to be entirely abandoned on one hand, or given an improved location on the other. For established lines the solution of a problem in compound interest determines the economical course.

A comparison should be made between the cost of a permanent structure and the capital to be invested to provide for the construction and maintenance forever of a temporary structure. To ascertain this we must consider a sum which is made up of the initial cost of the temporary structure, to be expended at the present time, plus an amount which at current rates of interest compounded will at certain recurring intervals of years, representing the life of the temporary structure, provide an amount necessary to rebuild it whenever it may be worn out.

Let

S = The above sum.

I = Initial cost of temporary structure.

P = An amount which at intervals of "n" years (the life of the structure) at current rates of interest compounded will produce I.

r = Current rate of interest.

n = Life of temporary structure.

$(1 + r)^n$ = Expression for compound interest.

Then

$$S = I + P \qquad (1)$$
$$P \times [(1 + r)^n - 1] = I.$$

$$P = \frac{I}{(1 + r)^n - 1.} \qquad (2)$$

Substituting

$$S = I + \frac{I}{(1 + r)^n - 1.}$$

$$S = I \times \frac{(1 + r)^n}{(1 + r)^n - 1.}$$

For example, what amount may be expended at the present time to replace a wooden trestle 100 feet long, costing $1,000.00, and having a life of 10 years, rate of interest 5 per cent.? $(1+r)^n$ being the expression for compound interest, $1.60 at 5 per cent. for 10 years amounts to $1.63. Substituting in equations (3), we have

$$S = 1000 \times \frac{1.63}{.63} = 2590 = I + P$$
$$P = 1590.$$

Therefore, $2,590.00 is the amount which is practically set aside for the construction and maintenance forever of this trestle in wood. One thousand dollars of this amount is taken to rebuild it at the present time, and the remainder $1,590.00 is placed at interest to again accumulate $2,590.00 at the end of 10 years. An expenditure of at least $2,590.00 is therefore justifiable for permanent improvements. If this trestle is replaced by a culvert and earth filling, the saving from annual maintenance of the temporary structure should also be considered. If this amounts to 25 cents per foot, or in this example $25.00 per year, the capitalized amount is $525.00 to be added to $2,590.00. If replaced by an iron span, the maintenance saving is less. If 5 per cent. interest is considered excessive, a reduced rate may be used, which increases the capitalized amount: In this example, at 4 per cent, $3,083.00 is a justifiable expenditure; at 3½ per cent. $3,440.00.

It is to be observed that an expenditure of $1,000.00 for a structure to last 10 years is not represented by a rate of $100.00 per year, as is often stated. One hundred dollars capitalized at 5 per cent is $2,000.00, to which if added $1,000.00, the present expenditure makes $3,000.00, instead of $2,590.00, as above determined. One thousand five hundred and ninety dollars and not $2,000.00 is the amount from which the annual rate is ascertained, and in this case is $79.50, not $100.00. For proper determination of these values it is always necessary to apply compound interest.

The amount to rebuild permanently may be in excess, still its expenditure is justifiable, as there is no certainty that the temporary structure will last its expected term of years; for instance, a total loss from fire, with additional loss from interrupted traffic, is always liable.

In conclusion, your Committee in its next report hopes to amplify and enter more into details upon the subjects reviewed in this preliminary report, and to be guided by the result of the discussion which it is hoped this report may bring forth.

(4.) The division of design has been deferred until the next report, at which it is our intention to consider a series of typical designs and methods of construction with, if practicable, the reasons entering into the adoption of the various types, it being the design of the Committee that the subject-matter of this report be thoroughly digested and criticised before entering into the final field of design and construction.

The Committee is indebted to Mr. W. H. Moore, of the New York, New Haven & Hartford Railroad, for valuable information.

W. L. Breckinridge, *Chairman,* Chicago, Burlington & Quincy Railroad;
E. P. Dawley, *Vice-Chairman,* New York, New Haven & Hartford Railroad;
William Hood, Southern Pacific Company;
H. G. Kelley, Minneapolis & St. Louis Railroad;
W. E. Hoyt, Consulting Engineer;
F. S. Stevens, Philadelphia & Reading Railway;
C. F. W. Felt, G., C. & S. F. Railway;
B. T. Fendall, Baltimore;
F. M. Bisbee, Tennessee Central Railway;
C. E. Lindsay, Southern Railway;

Committee.

The President:—Copies of the report are in the hands of members. We will now listen to the remarks of the chairman.

Mr. W. L. Breckinridge (Chicago, Burlington & Quincy):—I believe there is nothing radical in the report. It is merely preliminary and introductory. One point to which I would call attention is the classification of stone masonry. The first meeting of the Association asked for an exact definition of the term "masonry" and also the method of determining the comparative value of temporary and permanent structures. This report answers these two questions.

Mr. G. A. Mountain (Canada Atlantic):—Relative to the adoption of the term "masonry," I might say it looks to me as if we were departing from the recognized practice in embracing under the head "masonry" the term "concrete." I think the word masonry defines itself largely; masonry is the work of a mason; concrete is not. The point came up in a lawsuit whether a man who had a contract for the masonry had it for the concrete also. It was decided he had not; that masonry was the work of a

mason, and concrete was not. Bricklaying also comes under the term masonry. It would be nicer if we could get them all under one term, if we would not be going outside of precedence, especially if it could be done without any difficulty.

Mr. Breckinridge:—I believe it is the idea of the Committee to consider concrete as masonry and to make the definition of masonry include it.

Mr. D. D. Carothers (Baltimore & Ohio Southwestern):—It seems to me that this Association is quite competent to make definitions, and words that have not a clear meaning will have one after we have decided the matter among ourselves. Concrete is one of the words that has caused a great deal of misunderstanding, and it has been difficult to find a proper expression to cover it, and I think it is the duty of this Association to make an expression to apply to this material, and the one that is here used, it seems to me, is applicable.

Mr. Breckinridge:—I will say that the original term masonry, as near as I can find out, was applied to a profession; a mason was anyone who worked with mortar, or laid material in mortar.

The President:—The subject of masonry and the definitions that fall under it seem to have been very well considered by the Committee. The controversy as to the classification of concrete is an old one, and one difficulty is that terms and definitions for our profession have largely been compiled or decided upon by men who were not technical—men who have assisted in the compilation of dictionaries and encyclopedias and works of that sort. It is only in comparatively recent years in which engineering associations have discussed these questions, and the entire matter of definitions is practically an absolutely new one to us. It would therefore seem perfectly proper for us to fix our classication and definitions—do it ourselves, and not permit the makers of dictionaries to do it for us.

Mr. Mountain:—I agree with the Committee in adopting that word, but of course we have to be to some extent careful not to get at variance with what the term means. I mean that if we get it into our classification of masonry, and we were engaged in any controversy between lawyers, they would throw it out, at the present time, anyway. I quite agree that it would be a very nice thing to get concrete under the head of masonry.

Mr. W. McNab (Grand Trunk):—I notice in the report that the primary requisite of masonry is cheapness and the second requisite is durability. Would it not be better to combine these two elements—cheapness with durability—because masonry that is cheap may not by any means fill the requirements?

The President:—The report is practically divided into two elements. One is the recommendation of a classification and subdivision of terms, and the other is the general comment and explanation in reference to these subdivisions. The recommendations of the Committee, it seems to me, would call for some action—either the receipt of the report and the adoption of the recommendation in a tentative way, or the referring of the recommendation back to the Committee for further consideration.

Mr. Carothers:—In the definitions it is said that "first-class masonry will include all cut stone work, ordinarily coming under the head of arch and ashlar work." It seems to me the definition should be enlarged more and not refer to "ordinarily." The definition should be comprehensive in itself, without reference to what might have been the practice heretofore.

Mr. A. W. Sullivan (Illinois Central):—I observe the Committee have presented no definition of the generic term "masonry." It has definitions for various kinds of masonry, but not for masonry itself, except, perhaps, on the first page, where, in the second paragraph, will be found the statement, "The term 'masonry' will be used to apply to any material laid in mortar." Now I hardly think that is a definition. Furthermore, I hardly think it means what it says. "Any material laid in mortar" would include wood, which could be laid in mortar, or iron, or any of the metals. It is evident the Committee has in mind any of the materials which are ordinarily laid in mortar, but that is not what it says, and it seems to me that to make the Committee's work complete, it should contain a definition of masonry.

Mr. Breckinridge:—The term masonry, being used to apply to any material laid in mortar, refers only to material treated in this subject of masonry. On page 2 the materials are given as stone, brick, sand, etc.

Mr. J. H. Abbott (Cleveland, Lorain & Wheeling):—Do I understand that dry masonry, as we call it, is excluded from

the definition? I judge this to be so from the language used. On our road we are adopting that form of masonry a good deal, yet this definition, as I understand it, excludes what is called "dry masonry." We are building a large number of culverts that require as much masonry skill in shaping them and laying them together as if they were constructed with mortar, in fact, a little more.

Mr. W. S. Kinnear (Michigan Central):—I would ask the Committee if there is not a typographical error in the definition of second-class masonry, where they say that this class "will include all range work, where stones have parallel top and bottom bed dressed to side and laid either in parallel or broken range?" I believe the word "range" in the connection used is an error, and I suggest that it be omitted.

Mr. Hatch:—I think what the Committee meant by that definition of second-class masonry was that the stone should have parallel beds, and stone work may be parallel range or broken range. I think the definition is all right, according to my understanding of mason work.

The President:—What shall we do with the report? If it were not for the recommendation of the Committee, we could simply take it as a progress report and excuse the Committee; but it is due the Committee—having made a recommendation—that action be taken.

Mr. H. F. Baldwin (Chicago & Alton):—As I understand the recommendation of the Committee, it is that the definitions they have submitted shall be adopted, and, with that understanding, I move that we do adopt the definitions they have given us, leaving it to the discretion of the Committee to add such further specifications and definitions as may be necessary in order to make the next report more comprehensive and better understood by all. My idea is that the Committee should be given plenty of latitude, so that if on further consideration they find they want to make some change—for example, get a better definition of the term "masonry"—they shall not feel we have tied them down to the present definition of masonry.

The President:—It is moved and seconded that the report of the Committee be received and that the recommendations as to classifications and terms be adopted, subject to additional defi-

nitions or changes of the definitions as the Committee or the Association may desire in the future. Are there any remarks on the motion?

(Whereupon the motion was put to the Association.)

The President:—The report is received and the definitions adopted. There are many ideas and suggestions in this report we should discuss and get an expression in the way of opinion or the experience of the members. A large amount of monolithic concrete work has been constructed on various roads, particularly in the Middle West, in the last ten years, and the experience of members with that form of construction would be very interesting. If Mr. Parkhurst of the Illinois Central Railroad is here, I would ask that he give a description of the larger size culverts and arches in which he has used that form of construction? Is Mr. Parkhurst present?

Mr. Mountain:—The question of the relative cost of masonry or concrete in abutments is interesting. The road with which I am connected is doing a lot of that work with concrete. In the old days it used to cost seven, eight, or nine dollars per cubic yard for masonry. There are places at the present time where there are wooden trestles, which have reached their limit of age, and we simply make a mold, usually dressed lumber on the inside, to make a better facing for the concrete, and handle our concrete with a mixer. I have not the cost of that work completed, but the price on the basis of hauling the cement about 300 miles from its port of arrival, sand in close proximity, and labor at our usual rate of $1.25 a day, we find we are able to put in the concrete for $5 a cubic yard, thus making a saving of more than half, as compared with the cost of the ordinary masonry. It is necessary to vary some of the timber work. Our experience has been so satisfactory that we have adopted the concrete form entirely and would not think of going back to the masonry at all for doing this class of work. It would be a nice piece of information from the Committee if they would go into the question of the classification and specification of concrete, as to the different properties of concrete, and which concrete we should use. Of course every road has its own particular kind that it uses.

I might also add a reference to the recommendation of the Committee where they allude to brick. I speak as coming from a northern country. Our experience is that our brick-pipe culverts have had to be taken out. The frost has torn them to pieces. We have had to take out absolutely every one of our brick-pipe culverts, which were three feet in diameter. Whether it was inferior brick or not I am not prepared to say. In reference to concrete, the results have been such with us that we would not think of adopting anything else.

The President:—For the information of the Association I would state that the brick piers of the Illinois Central Railroad south of the Ohio River have given satisfactory service for over forty years. The frost in that section is not severe. We use brick for end-walls of culverts almost entirely south and concrete north of the Ohio River. If Mr. Dougherty is here, he might give some information in regard to the large concrete arches on the Illinois Central in the double-track work.

Mr. C. Dougherty (Illinois Central):—We have on the division with which I am connected two concrete arches. We took out the iron single-track span and replaced it with a double-track concrete arch. One of these arches had a diameter of 40 feet inside; the other is a combination of a 38-foot arch and a 10-foot arch. The thickness of the concrete at the top of the arch in the 40-foot span, I believe, is 27 inches. These culverts were completed during last season, and so far they are holding up well. Portland cement was used in these arches.

The President:—Mr. Dun, can you say anything about the use of concrete on your road?

Mr. James Dun (Atchison, Topeka & Santa Fe System):—I can only speak of this matter in a general sort of way. We have been using concrete rather extensively, particularly in small culverts. Owing to the high price of iron pipe we have found numerous places where concrete was more economical, but we have no very large arches or structures of concrete. Stone in our section is generally cheap, and we use vitrified brick for the rings of arches. The result has been satisfactory. In the track elevation and depression work near Sixteenth and Clark streets, Chicago, there were some 18,000 yards of concrete used, which has proved, I think, as good as it would have been if built of

first-class masonry. It would have been impossible to build masonry there owing to the contracted space for the work. I believe that result of our experience is that good Portland cement concrete is fully equal to the best masonry, and probably better than most of it.

Mr. M. W. Cooley (National Contracting Company):—I had charge this last summer of the construction of a double-track concrete tunnel for the State Commission in Massachusetts. We made a horseshoe tunnel, a solid mass of concrete top and bottom, usually in soft clay with considerable water in it. The outside ring was laid 6 inches and painted with an asphalt coating to keep the water out. Then the balance of the concrete, about two feet, was run around on the interior. It made a very handsome piece of work. Our section of the work was about 1,000 feet and it was very satisfactory. The cost was $7.13 a yard, laid in this somewhat expensive way. The work was laid entirely with Portland cement, in the proportions of 1, 2 and 5. Sinkage cracks have been noticed in the work, especially that which was laid in the hot summer months. I do not know why it should be liable to crack more in these months than others, but they develop more then than at any other time.

The President:—The use of concrete on the Illinois Central Railroad has extended over the last ten years, and during that time culverts have been constructed in South Dakota that have withstood the most severe weather. Its value depends, first, on the cement, and, secondly, on the thoroughness with which the materials are put together and in the mixing. With care in these two things—a first-class cement and thorough, careful mixing—the results have been first-class, and the cost has been generally from one-half to one-third what cut stone would have cost in the same locality.

Mr. G. W. Kittredge (Cleveland, Cincinnati, Chicago & St. Louis):—Our road has used concrete construction very largely during the last three years; in fact, there has hardly been a piece of first-class cut stone work on the road during that time. The largest single piece of work was a construction of a double-arch bridge, each span of which was 34 feet in diameter. There are something like 1,200 cubic yards of concrete used in these arches and in the wing walls. The wing walls and the lower part of

the structure were built with natural cement for the core, with a Portland cement facing of about 6 inches, and the arches were made all of Portland cement, using the American brand. The cost of that work complete, exclusive of the preparation of a foundation, which, of course, varies with every structure, was $4.23 a cubic yard. That included all the cost of handling the material at the work, but does not include any freight charges on the material over our own lines. The cement was hauled over 250 miles, the broken stone was hauled from 80 to 90 miles. We made a charge for the timber that went into the centering and into the forms when it was first put in, and allowed a credit for the value of such material as it was taken out. That is the largest piece of archwork we have done. Our arches are much thinner at the crown than the stone arches we have been using on the Big Four. The stone we used mostly on the Big Four has been a sandstone, such as is found up in the northern part of Ohio. In concrete we have reduced materially the thickness of the ring stones at the center and proportionately at other places. In our retaining walls we have maintained nearly the same thickness we would have had in the stone.

Mr. W. K. McFarlin (Delaware, Lackawanna & Western): —We put in two interesting pieces of concrete work the past season, one over the Hackensack River in New Jersey. At this point the river is 57 feet deep and about 35 feet of mud at the bottom of that. We put in a draw span 220 feet long and four 120-foot spans, using concrete for the abutments, center and rest piers. There were 4,000 yards of concrete in the seven piers. The bridge is placed but not yet in use. There were 4,900 barrels of cement used in the 4,000 yards of concrete. The concrete was made of trap rock and Long Island sand.

We have just completed another piece of concrete at Buffalo over Evans' Slip, with 17 feet of water, rock bottom, it being a busy piece of track, and during the season of navigation from two to three hundred cars of coal are handled over it every day. We were anxious to get the work completed before the opening of navigation. The excavation was begun on December 1 by dredging to the rock, and a form put down to the rock as a guide to the concrete, which was put in in sacks.

The sacks were tamped and 12,000 sacks were used in the 800 yards of concrete. It is completed and looks well and set well. We used gravel containing its own proportion of sand. Wooden tampers were used until the work was to the water line. The neat form was built at water line and continued to the surface, which was about 8 feet above the water. The work cost about $5.50 per yard, not including the dredging. A barrel of cement was used to a yard of concrete. It is going to stand; there is no question about that, as it has already set up. When it was completed to the top of water, the weather was 15 degrees below zero. The forms were housed over and we put stoves in and finished the work in a hot room. The frost did not touch it in any way.

Mr. Mountain:—I want to ask if the material of which the sacks were made was very open—if the material was very open material?

Mr. McFarlin:—Have you ever noticed two cement sacks together—sticking together? They will never break at the joint. There is a bond cement that forms that is stronger than any part of the cement. You cannot pull the two apart.

Mr. Mountain:—You covered it over with the house and put it in while it was warm. Do you think it affects concrete in any way to put it in the water at any temperature?

Mr. McFarlin:—The temperature of water never gets below 32.

Mr. Mountain:—What is the object of heating? Would it affect it even at that? Would it chill the cement or concrete?

Mr. McFarlin:—No, sir; we did that work in the warm house.

Mr. I. O. Walker (Nashville, Chattanooga & St. Louis):—We have just completed a concrete culvert under a bridge 65 feet high. The concrete arch is 18 feet span and 18 feet 2 inches from the foundation to the crown of the arch inside. The first problem that struck us was that the outside dimensions of the arch were too great to go in between any spans in the trestle, and we got around this by building one bent of the trestle into the arch. The axial line of the arch coincides with a bent of the trestle, and the arch is high enough so that the crown of the arch came above the pile cap; it is a frame trestle, and

the piles in the lower deck are about 15 feet high. That left the posts of the trestle in place and we boxed around them, so that now after moving the boxes the concrete lacks about 2 inches of touching these posts anywhere, and in the spring we are going to remove the posts and plug up the holes with concrete and carry the bent on a substructure resting on earth on each side of the arch. We made no allowance for expansion. The arch is 211 feet long and contains about 2,000 yards of Portland cement and about 200 yards of Louisville. The Louisville cement is used in the foundation. The culvert rests on about 30 inches of Louisville cement and the body of the arch is composed of Old Dominion cement mixed in the ratio of 1, 3 and 5 and the crown is of Alsen cement mixed 1, 2 and 6. The whole structure is faced with 2 inches of Alsen Portland cement, one part of cement and two of sand, and carefully rammed in place just a minute ahead of the filling in of the concrete, so that we get a close connection between the face and the concrete proper.

The President:—It is now one o'clock. If there is no objection on the part of the members the Committee will be excused, and it is a question whether or not an afternoon session should be held to-day. Dr. Hermann Von Schrenk of St. Louis, Mo., connected with the Department of Agriculture, is with us, who will give us about a twenty-minutes' talk in connection with ties and their decay. He has some valuable data which will be given in connection with the Tie Committee's report. It is suggested that we adjourn to meet at 2:30 this afternoon, if it meets with the views of the Association.

(Whereupon the meeting adjourned until 2:30 p. m.)

TUESDAY AFTERNOON SESSION.

At 2:30 o'clock the meeting was called to order, Vice-President Peterson in the chair.

Vice-President Peterson:—It is desired that we shall resume the discussion on the report of the Committee on Masonry. We will ask Mr. McDonald to open the discussion.

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis):—I am in hopes that the experience of the members

will be drawn out in this discussion so that we can all benefit by it. We have only taken up this matter on our road within the last twelve months, but the results are such as to warrant us in the continuance of the use of concrete, especially in view of the fact that the price of Portland cement has fallen so much that it makes absolutely the cheapest masonry that can be built. One of the questions which presents itself to us in this matter is whether the quality of the cement should be determined by inspection on the ground as the work is carried on, or by a testing bureau at the point of manufacture. Our President has said that the principal thing was the quality of the Portland cement, but a novice in the testing of cement will find he has a good deal of trouble in telling whether it is properly tested or not. The next point that is important is the quality of the sand, and the next is the sizes of the aggregate particles that go to make up the concrete. The quality is not so important, provided it is durable and has sharp edges.

The most instructive lessons are usually the failures, and while our members are generally free in telling us about their successes, they are rather reticent about talking of their failures. I have not been using concrete above ground long enough to personally report any failures, but I believe there are members present who have had failures, and I think their experience will be of great benefit to the profession. Among some of the failures I have heard of is the absolute inability to secure a uniform junction between the Portland and natural cement concrete. In other words, it has been attempted to make a core of natural cement and an exterior of Portland, but as far as I have heard the matter has not been successful, and I think the present practice is to use a poorer mixture in the body, and face with a richer mixture of mortar. Another problem in the construction that has to be solved is the treatment of the faces—how to obliterate the markings of the molds; how best to chip off the rough places and coat the exposed surface, and what to cut it with. I think the Association would be glad to be enlightened on all these matters, and it is possible the Committee has collected a large amount of data from the various roads as to what their practice has been, and I hope the Committee will finally publish as an appendix to this report such data as they have collected which they think will be of interest.

Mr. E. E. R. Tratman (Resident Editor Engineering News) :—There is one point I observed apparently omitted from the report, and that is reference to the use of steel in concrete. At the present time there is a tendency to use steel beams, rods and wires, in combination with—and imbedded in—the concrete. I think that might have an effect on the classification diagram given in the report.

Mr. H. W. Parkhurst (Illinois Central) :—During the last year in double-track work on our main line, between here and Cairo, we have replaced two bridges of about 80 feet span. The waterway in each case was largely in excess of the needs and the idea occurred to some of our engineering staff to substitute concrete masonry in the place of the iron bridges. In one case the depth from the grade line to the ordinary low water of the stream was more than 40 feet; in the other, 26 or 28 feet. In the latter case a roadway passed through under the original bridge as well as a stream. The openings or the valleys in both cases were rather narrow and the original masonry was the abutments on each side, with iron spans between. They made rather good cases for the use of concrete arches. We have replaced the larger bridge with a double concrete arch, one of 36-foot and one of 10-foot span, built for double track, and the length over all is 35 feet from face to face of masonry. The pier, which is already as heavy as would be required for the abutment of the 36-foot arch, separates it from a 10-foot arch for the roadway. The floor of that arch is at a considerably higher level—I think about 5 feet—than the ordinary low water of the stream. The range of the water in the stream is only 7 or 8 feet. The drainage area was carefully examined to see if the substitution of this much smaller waterway would be harmful, and it was decided it would be entirely safe. The 36-foot arch is a full center arch, with about two or three feet of free height from the springing line to the low-water level, and the depth of the water of the stream is only two or three feet. Sometimes it is nearly dry. At each end of the parapet the usual wing walls, built at an angle of about 30 degrees with the axis of the arch, are constructed, and these are built of sufficient thickness to withstand the thrust of the earth slopes.

There is only about three feet of filling on the top of the crown of the arch, under the ballast—I think three feet, including

the ballast. It was finished last fall, and it has been in operation ever since. It is built of Portland cement concrete, with natural cement concrete in the foundations. We found a very substantial, almost stratified clay beneath the original masonry and adjacent to it, and so we got a very good foundation.

In the other case a 40-foot full center arch, with about 6 feet height of bench wall from springing line to low-water level, has been substituted for an 80-foot lattice girder span, with the same style of construction, and this has 12 feet fill on the crown of the arch. All the falsework has been removed, and it is now carrying the traffic. That work was completed in December of last year. It became quite a problem to judge whether it would be safe before spring to permit the load of trains and filling to be placed upon the arch, and we devised a method or system to determine this. We had some of the same kind of cement mixed into briquettes, with pretty large proportions of sand—two or three parts—and we made a test from time to time to see what progress the mortar was making toward setting in the outside air, exposed to the same conditions as the arch itself, if not worse conditions. It was found at the end of four to six weeks' comparing the tests of these briquettes, exposed to freezing and thawing, that they had about from 70 to 75 per cent of the strength of the same briquettes that were exposed to the ordinary temperature of a warm room at 70 degrees. The setting seemed to proceed in spite of the cold weather. We were able to complete the concreting of this large arch before there was any freezing weather—I think the lowest temperature was 20 to 24 degrees for one day only—so that we were pretty sure the concrete had thoroughly set before any loads were imposed upon the arch, and tests were made subsequent to that time to give some idea of the rate of setting of the concrete in a large piece of work. It seems to do its duty without any trouble.

The keystone of the arch, I think, was two feet three inches in the 40-foot arch and 24 inches for the 36-foot arch. A comparison was made of several formulas—Rankin's, Trautwine's, Baker's, and various others. They gave pretty nearly the same results. I think there is rather a percentage in favor of the concrete as compared with stone in its ultimate strength. With the arch ring in the case of the larger arch, we took special pains, as

that was liable to be exposed to worse conditions than the other, as it was built before cold weather. It was built and tamped down in lines as nearly radial as possible. We were not perfectly exact about it. A section from 7 to 9 feet long was built at one time, commencing with the parapet wall at one end of the arch, and completing it before starting the next section. The parapet stands in the center about 4 feet above the top of the crown of the arch. Each arch section was built approximately 8 feet in length. A separate form, the exact cross-section of the masonry desired, was supported in place, and the 8-foot section built in between the parapet wall section and the partition, and then the partition was moved and the sections built in successive order. The parapet wall of the far end of the arch was, I think, built before one intermediate section on the left, and that finished the work. We had to build this last section underneath the span; it (the span) was supported on flat benches, one made on the crown of the arch and one near each haunch. Posts and sills were put on these and supports built up to the existing iron work. The track was carried on these supports for two and one-half months, while the filling was carried on, and until the filling was completed. They have only been removed in the last ten days or two weeks.

Vice-President Peterson:—Mr. Parkhurst, can you give us the drainage area of the country the waters from which passed through these arches?

Mr. Parkhurst:—The larger arch had a smaller drainage area than the other. There was really nothing to be obtained from a comparison of the drainage areas. In the case of the larger arch, the slope from the level of the Illinois prairie country is much more abrupt than in the case of the other, while the drainage area is not over half as large. This data was obtained by barometrical observation and without any exact level.

Mr. McDonald:—Do you consider it practicable to carry on the construction of large masses of concrete masonry continuously? A great many specifications provide that the concrete work shall be carried on continuously. I have found great difficulty in doing it, and I would like to hear from someone else on that point.

Mr. Parkhurst:—Our experience has been that it is not advisable to carry it on continuously, with this particular exception I

referred to. We stop our concrete work in October, generally, but occasionally run it into November. This arch referred to was located nearly 200 miles south of Chicago, in a considerably milder climate than we have here, and we were watching continually the chances of the weather and the actual weather, preparatory to stopping our work if it became too cold. I do not consider that concrete should be put in if it is exposed to hard freezing weather during the process of its construction.

Mr. McDonald:—What I meant was the arch and side walls—do you think it practicable to begin at the bottom and complete the whole structure without ever letting the concrete set in the meantime? In other words, so that fresh concrete will never come in contact with concrete which has already set?

Mr. Parkhurst:—No, sir; I do not think it is wise to do that. We do not try to do that. We try to work in such a way as to complete each one of the arch sections as a monolith, without having it set from the time it was started on until it was through with; but in order to do that we build the bench walls up 3 to 4 feet on the haunches beyond the springing line and carry up the skewback to correspond exactly to the radial line at that point. The thickness of the arch at the point when we finished off these skewbacks was approximately between 7 and 8 feet. That was finished off as nearly as may be to a radial line, or within 2 or 3 inches of it. These sections, which contain from 40 to 50 yards each, were built in monolithic masses. They were started and carried up from each side and met at the top and finished and rammed before we stopped work, and that meant working after dark in some cases.

Vice-President Peterson:—We would like to hear from some gentleman who has built concrete arches and other concrete structures as to what success he has had with them. Mr. Baldwin, can you give us the benefit of your experience?

Mr. H. F. Baldwin (Chicago & Alton):—My experience with concrete has not been very extensive. Until recently I have been in a section where we had a good sandstone, and we thought that was better than concrete. For the past year I have been with the Alton, and of course I am not now so much prejudiced against concrete. Last spring I started in to use concrete. Previous to that they had used a good deal on the road, but not with entirely satisfactory results. The work we did last year has generally proved

very satisfactory. We built some large piers over the Missouri River, and one large abutment containing something like 3,000 yards of masonry. We used Portland cement concrete for the back exclusively. We think the results are going to be good. I have, however, noticed one thing in connection with concrete masonry, where natural cement has been used in the body of the work and a Portland cement facing has been put on as the other was constructed. We have a good deal of concrete of this sort, where the outer shell of Portland cement has cracked off from the other, and I am convinced that it is a mistake to use natural cement and Portland cement together. Natural cement may be all right in foundation places where it is not exposed, but to build up a core of natural cement and surround it with Portland cement concrete is a mistake. The concrete work with which I am familiar has not stood sufficiently long to speak positively of its durability.

Mr. W. E. Dauchy (Chicago, Rock Island & Pacific) :—I would say a word with reference to the matter Mr. Baldwin speaks of, as to facing concrete with what we call Portland cement concrete. We have followed that practice to a large extent very successfully. I think much depends on the way it is done, and in putting in concrete and putting on such a facing, we have always found it necessary to break joints in the facing. That is to say, if we intend to put on a facing of 9 inches of Portland cement concrete, we would start in some such way as this: Putting in the first layer, we put about a foot facing of Portland cement, and the next layer we put in about 6 inches; the next layer a foot again, and so on up. By putting it in in this way we never found that the facing scaled off or showed any tendency to do so. I think, however, if it is to be put on as a facing only, with the same thickness throughout, it would give trouble.

Vice-President Peterson :—Don't you think it would be better to put concrete richer in cement on the outside and concrete poorer in cement on the inside; that is, make it three to one on the outside and six to one on the inside, and ram these two kinds together in a solid mass?

Mr. Dauchy :—Yes, sir. Our method of doing it is this: If we desire a facing of certain thickness, as the material is dumped into the forms, a piece of sheet iron or something that can be readily set up is placed between the divisions of the mixture,

natural cement placed upon one side of it and Portland cement upon the other, and then this division removed and the whole thing tamped in together. By doing that and then breaking the joints as I speak of, I have never found a particle of trouble in having the Portland cement concrete stand well, and I have used it for the past four or five years quite extensively.

Vice-President Peterson:—We all want to hear of some failures that have taken place. Will anyone tell us of a failure that has taken place in work that he has had charge of?

Mr. G. W. Kittredge (Cleveland, Cincinnati, Chicago & St. Louis):—I think it takes a good deal of nerve to get up here and say you have a failure [laughter], but as I have only one case to chronicle, and that was where we started out with a great deal of doubt in our own mind as to whether it would be a success, I don't mind telling about it. It was a foundation for a crane in one of our bulking yards. We put up a 20-ton crane, and through some delay in the delivery of the machine, we had to carry it into December before we erected it. The foundation was about 10 feet square. We set the anchor rods and anchor plates in the concrete and built up around it. But the day after the foundation was finished it turned very cold, and for nearly a week after the thermometer hovered around the zero line, or from zero to 15 degrees above, and we found that the whole block of concrete was practically ruined. It was built with Portland cement. That illustrated to my mind the fact that it was not a good plan to have very severe weather follow closely on the placing of the concrete, that is, before the concrete had got a permanent set. Just what length of time should elapse before severe weather would affect it, I am not prepared to say. I would like some information on that subject, but I am satisfied that one week after the work has been done the concrete will be injuriously affected by severe weather.

Mr. McDonald:—Do you use salt in the water?

Mr. Kittredge:—I can't tell at this date whether or not we did. It was a year ago that we had the experience.

Mr. R. Trimble (Pennsylvania Lines):—I saw a piece of concrete work about a year ago last summer, on our lines. It was a failure. When the concrete was put in it seemed to be a pretty good piece of work, but in about a week it all went to pieces. When we came to investigate the matter we found that the failure

came from the cement. The Portland cement was shipped without proper seasoning and the free lime expanded and the concrete went to pieces. That shows we cannot be too particular about the cement we put in our concrete. In line with this I know of the failure of a piece of masonry from the same cause. The cement was shipped before seasoned, and the expanding action took place, and, of course, the stone was forced apart, so quite a lot of the masonry had to be taken down and rebuilt.

Mr. A. S. Markley (Chicago & Eastern Illinois) :—I desire to confirm what Mr. Baldwin said in reference to Portland cement facing. We have had two or three failures in that direction, but only on tank foundation, which occurred in the last year. We have been using concrete for the past seven years, and aside from those three failures we have not had a single instance of a failure of any kind whatever. We have built piers 35 feet high carrying 150-foot span, putting the load on in less than three weeks after the concrete was completed, and it had no evil effect whatever on the concrete. The third failure that I refer to was made of natural cement core and the facing of Portland cement was about 3 inches thick. Inside of two weeks after the job was completed it commenced scaling off on the outside, though the inside was as solid as any concrete could be and showed no signs of failure whatever. We attributed the cause to the shrinking of the outside. The outside shrinks faster than the inside. We aim to do our work when there is no freezing weather. I quite agree with Mr. Parkhurst that we are taking desperate chances in doing work of that character in freezing weather, though this year we have been compelled to do it. I don't hear anyone express himself about mixing concrete. I should be very glad to have the members express themselves in that direction, whether they used machines or not, and if so, if successful from an economical point of view.

We used to drop our sand and cement upon the board and make a regular mortar of it, and then put our stone in, which necessitated our mixing everything wet, and it was very hard on the men. It was almost impossible to get men to stand up to the work. In our last year's experience in using it dry we found we had no trouble to get men and no trouble to get them to stand up to the work. Our price varies from $3.50 to $5. Our last year's

work, where it was about half and half arching, averaged $5.16 per square yard of concrete.

Mr. D. J. Whittemore (Chicago, Milwaukee & St. Paul) :—I should like to inquire whether the backing was made of a concrete of Portland cement, or whether it was of the natural American cement.

Mr. Markley :—In our case it was a natural American cement.

Mr. Baldwin :—The core was of natural cement, the facing of Portland.

Mr. Whittemore :—It was my lot some twenty-five years ago to investigate the action of natural cement and incidentally Portland. In my investigation I endeavored to ascertain how the two would operate when mixed. I am speaking now of twenty-five years ago, and so far as I can recollect the mixture of natural and Portland cement amounted to an adulteration as much as though we had put in sand instead of natural cement. I was quite strongly confirmed in the opinion that the attempt to join the Portland cement with the natural cement was like putting water with oil, and I should like to know from the tests you mention whether you have had a test of Portland cement facing against a Portland cement backing. It strikes me that some of these failures, and perhaps nearly all of them, have resulted from the use of Portland cement facing on a natural cement backing.

Mr. W. B. Hanlon (Cleveland, Lorain & Wheeling) :—At a meeting of the Ohio Institute of Mining Engineers, week before last, Prof. Edward Orton, State geologist, made this statement in regard to Portland cement. He said that several brands of Portland cement on the market made from rocks in Pennsylvania were not entitled to the name at all. They should not be classed as Portland cement. He did not name the brands, but that was his investigation of the rock and the manufacture. During the last year I have used a great deal of Portland cement, and had a test made from each carload, and in several cases I have had to hold a carload until it became cured. It was too green at first, too much free lime in it. After holding it four or five months it was used as good cement.

Vice-President Peterson :—Testing cement, as we all know, is a very important matter, and we would like to hear from some member who has had experience in the testing of cement as to which form has been found to be the most satisfactory.

Mr. Kittredge:—One of the members a few minutes ago said that he had not had any failures himself, but some of his neighbors had. We have not been testing Portland cement on our line much, but the Baltimore & Ohio Southwestern have had a test and perhaps Mr. Carothers can tell us about it. We all like to refer to our neighbors when we have a chance.

Mr. Markley:—I would like to know how the gentleman handles the testing of cement. So far as the Chicago & Eastern Illinois is concerned, we cannot hold the carload of cement long enough to make a test. We never find out the result till we get all through. We have been using Portland cement for nine years and have never rejected any portion of a carload. Of course we make tests for the satisfaction—after we have used it—of knowing what we have used. To determine if the cement is first-class by the 28-day test, there must be some provision made for storing cement until this test is accomplished. This necessitates extra handling of each carload used. If stored in cars, car service rules and charges are applied and charged against the structure. Besides there are some very hard and unsatisfactory questions to answer why the car was delayed in unloading, if no previous arrangements had been made for delay of car. We are very glad to have our neighbors continue on testing. We, of course, get some of the benefits of their rigid requirements.

Mr. Parkhurst:—I don't know that I want to answer all Mr. Markley's conundrums, but possibly I can throw a little light on it. We have been in the practice of testing our cement before it was used, as a general proposition. Our specifications provide that the contractors shall deliver it in time for it to be tested, and while it sometimes makes difficulties, it does not do so in the majority of cases. They are required to provide storehouses for cement and to unload it and put it in the storage houses, and if it chances to be rejected they have to reload it and ship it away. That, I think, can be secured by specifications, and by insisting on compliance with them. For the purpose, however, of getting at the quality of the cement we do that by means of tests of neat cement, and samples are sent by the inspector in charge of the work the moment cement is delivered on the work. Those samples are sent to the central office here in Chicago. The equipment of the office is sufficient generally so that those samples can

be made into briquettes within one or two days of their receipt, and the tests are made on a 24-hour test of neat cement. At the same time, however, briquettes are made so that 7-day and 28-day tests can be made from the same lot of cement. Samples are selected at random from 10 or 20 or 40 packages in a car, depending on the size of the packages, and enough are sent so that three sets of briquettes can be made, 10 in a set. At the end of 24 hours, if that test does not show quite satisfactorily, and the cement is not necessary, we do not reject it. The 7-day test is made to determine it, and after the expiration of that time the cement is either accepted or rejected. The 28-day test is a matter of confirmation of the others. It is a matter of record, as Mr. Markley says, of the tests that they are in the habit of making. I think we put in about $140,000 worth of concrete last year, in which the cement for the work was tested in general in that way. I have had occasionally a telegraphic request to allow a carload to be used before the record of the test was sent to the inspector, and depending somewhat upon the result of other tests of the same brand of cement, we have allowed them to use it or refused to allow them to use it, according to former results. As a general proposition, however, the percentage of rejection has been extremely small. I only remember two carloads all last season.

Mr. C. Lewis (Baltimore & Ohio Southwestern) :—During the last two years we have done a good deal of concrete work on the Baltimore & Ohio Southwestern, and the charge of testing the cement has fallen under my care. The work started out at first in a tentative way. We did not know exactly how we would have to do it. The contractors were purchasing their cement at any place where they could get the lowest price and shipping it on to the work, where it would be unloaded, and transported to wherever the concrete work was going on, which necessitated a good deal of trouble in unloading, and sometimes a long haul, and necessitated putting up storage place for it. The cement was sampled by the resident engineer in charge of the work, and the sample was sent into a cement laboratory that was established at Cincinnati, where it was put through certain tests, and if found satisfactory a notice was sent to the resident engineer that the cement could be used. Very often in that early period we had to reject the cement, and the contractor was under the trouble of loading it

up again into the cars. Usually the cement was bought under contract to meet our requirements, so that the freight charges were borne by the cement dealers. Nevertheless, it resulted in a great deal of delay and annoyance and expense. We transported the cement at a little below cost for the contractors, and so the railroads lost a little something, and the contractor was naturally as anxious as possible to keep a small lot on hand, as he had to provide storage room, so that it resulted in a great deal of inconvenience. The work was delayed and much money lost. It was finally decided to accommodate the mills on our own line by maintaining a supply of accepted cement on hand, and we entered into contract with a number of mills to that effect. Some of them agreed to supply us with bin storage, and others who had no room for that gave us storage for barrels after packing, and we made arrangements for inspectors to visit the mills and inspect the cement there, the samples being sent to the laboratory and tested as before. If the cement was satisfactory it was shipped out directly to the contractors in sealed cars, saving all delay and trouble. When contractors wanted to buy cement off the line, inspectors would be sent to the mill from which they wished to purchase it, at the contractor's expense, and we would inspect it there and sometimes load it at the same time, and if found satisfactory it would be shipped out. There was never any delay at the work. The cement always arrived accepted and in good condition, and if any were purchased we could count on it being used at once. The testing itself was right in line with average tests as going on throughout the country. We had to evolve our own specifications. We started with a specification which is a very common one, simply stating the cement was to be of a certain tensile strength and was to be sound. We gradually evolved a set of tests and requirements, and as the cement companies met them we kept increasing. Our idea was to have as high a requirement as we could get the mills to keep up to, and not increase the cost too much to ourselves for cement. We found we were greatly aided by a very efficient corps of inspectors at the mills; that by proper selection and by proper urging on the mill superintendent a very good grade of cement could be had at no extra cost whatever. If we had gone right to the company with a certain requirement they would probably have said, "This will cost so much more per barrel to get

out," but by getting it from day to day, we were able to secure a very high grade of cement at no extra cost. The requirements were the very usual one of certain tensile strength, both neat and with sand, that it should pass a boiling test, that it should show a constancy of volume, and that it should have a certain degree of fineness in the grinding. There has been a good deal of question raised as to whether it pays to take sand tests or not, and there are a good many technical points involved as to just what requirements we should make for sand and for tensile strength. I think our experience shows that a most important thing in good cement is not the actual tensile strength shown in breaks, but it is the percentage of increase in strength. A 1-day test is really of no value at all for Portland cement, and as you know it is a very hard thing to get 7 and 28 day tests on cement if testing it in the field, but if you are testing it at the mill, as we did, there is plenty of time to get a 28-day test, and the 1-day test can then be disregarded. A 7-day test should have a certain minimum strength, which need not be high. We found that a Portland cement which gave a tensile strength of about 350 pounds in seven days, with a good percentage of increase, was strong enough, but you want to get about 25 per cent increase. If we were going to get up any new specifications we would probably make some such requirement by specifying that the cement should show a certain strength at the end of seven days, with a certain required increase at the end of 28 days. You will find some cements doctored up to make a strong showing at the end of seven days, which will come down at the end of 28 days.

A great many mills objected to the boiling test. In fact, there was some talk of the American cement mills combining against any such test last year. It was at a period when cement was selling at over two dollars a barrel, and they claimed they wouldn't sell to anyone who specified the boiling test, but when cement went down to $1.60 any mill in the country apparently was willing to meet the boiling test. Some people say they see no connection between a boiling test and test in practice. It may be only a coincidence, but I will give it to you for what it is worth: We have found a very close agreement between our tests conducted in the laboratory and the way the cement shows up in the field. Work that has cracked and shown up poorly has

been made from cement that did not stand the boiling test. We have had cement that did not stand the boiling test that has apparently shown up all right, but I don't know of any case where it has been the other way. Even if so, we have certainly, I think, been on the safe side in rejecting cement that has not been able to stand the boiling test. Our greatest trouble has arisen from the effort to secure finely ground cement. Cement that is finely ground will usually give a high strength with sand. It is altogether a matter of management at the mill. Nearly all the American Portland cements are now ground very fine and will meet a requirement of 95 to 97 per cent through a 100 sieve. In fact, some of them are ground as fine as 99 per cent through a 100 sieve, but the natural cements have not come to any such degree of fine grinding as that. There is no reason why natural cement should not be ground as fine as a Portland. In fact, from the way they are burnt, it is easier to grind them. They are ground softer. But the mills have not been asked to do it, and don't do it. They are at present turning out about 90 per cent through a 50 sieve, which should be equivalent to 85 per cent through a 100 sieve, if a normal percentage of fine stuff were coming through. And that is what we have been requiring. As a matter of fact, you won't get that very often, but there is no reason why, if we were all to unite on it, the mills could not easily turn out a finer natural cement, and it would be a great improvement. With a good cement that has no free lime and is properly burnt, the whole value to the engineer depends upon how finely it is ground. The finer it is the coarser you can mix it up with sand and with stone, and therefore have a strong concrete of poorer mixture. The difference between a cement ground about 90 per cent through a 100 sieve and 99 per cent through the same sieve is offhand that it will give the same strength, 1, 2 and 4, and 1, 3 and 9. We have made mixtures up on that percentage that had the same strength, simply by that extra fine grinding. The silica cement that is at present on the market is a very fine sample of this and the results that can be obtained. You can take this silica cement which is ground up with sand, and, although it may be ground in the mixture of 1 to 2 of sand, you can use it almost as though it were ordinary Portland cement. We have artificially made preparations from other cements that showed very similar results.

The cost of conducting work such as I have mentioned is a matter that altogether depends upon the amount of testing that you do. If you can arrange to sample your cement at the mills in very large lots, for instance, if a road takes all its supply from one mill or from two mills, so that you could keep one inspector constantly employed from day to day, without any waste of his time in traveling, you could do all your testing in the laboratory at a uniform rate, so that you would not have to have a large force and a lot of apparatus and then lie idle for a time. Assuming that your laboratory force is kept constantly employed, the only difference then comes from whether you are shipping it from a single bin. If you are shipping from a single bin, you don't have to take so many samples. Three or four good samples will serve just as well as one sample from every second barrel would if you were packing from different bins. Some people inspect every barrel; others every other barrel. Our specification was every fifth barrel. Other companies inspect one in 10 or 25. There is any amount of variation. It is not possible to tell what it costs per barrel, but I can tell you approximately what it costs per briquette. With a force working full time it will cost a little over 7½ cents a briquette. That includes all experimental work, interest on first cost of plant, deterioration, etc., and is an average figure, including both natural and Portland cements. With the force working about half time, we found it cost us about 11 cents a briquette. The way we tested on the B. & O. S. W., we averaged about one briquette to every two barrels, so that the cost of the laboratory was, as a rule, between 3 and 4 cents per barrel of cement used. That, of course, included a great deal of experimental work. We are carrying on a lot of long-time tests and run out a good deal of experimental work on samples from mills that we don't buy from. The cost for all this has to be added to the cement you are already using, and raises the cost somewhat. The cost of sampling at the mill will average about 1½ cents a barrel. If you make a single shipment from one mill you have to send an inspector to it and pay his expenses. We found that a charge of five cents a barrel against the contractor amply covered the cost of this service, it usually averaging about three cents per barrel for inspecting at the mill in small shipments (not including transportation of inspector). The total expense to us for mill sam-

pling and for inspecting and testing at the central laboratory, including interest on the first cost of plant, stationery and all other incidental expenses, was about six cents a barrel on the average run of cement used for the last two years. It would go somewhat lower when everything was running nicely, and higher when conditions were not favorable.

Mr. Breckinridge:—In regard to large blocks of stone in concrete work—that is something on which I have no information.

Mr. Mountain:—I might say in reference to that: We take blocks that a man can lift of ordinary rubblestone, and run them out, and as we dump in a layer of concrete we throw these down. Generally a man is below and he sets them so that they don't adhere to each other, permitting the broken concrete to get in between anywhere from 3 to 6 inches, and I am satisfied that that takes up probably a third of the broken stone concrete. It is economical. I have only done it in blocks. How it would do in arches I don't know, but it is certainly economical in blocks.

Mr. D. J. Whittemore (Chicago, Milwaukee & St. Paul):—I wish to ask the gentleman whether those Portland cements that showed the highest tensile strength at seven days' test are not those that are the most dangerous from lime uncombined. It has been my experience that, when endeavoring to get an exceedingly high tensile strength, neat, I ran great danger of having it fly to pieces after a few days or a few weeks, perhaps months. The late John Grant, who first investigated the subject of Portland cement with anything like scientific ability, raised the seven-day standard requirements in the Metropolitan works of London, previous to his time, largely, but in doing this he found great danger from lime not combined. It seems as though where you are dealing with these high-tensile-strength cements, neat, that the hot-water test should prevail. I feel safer using a cement that does not show so high a strength at seven days, but shows a constantly increasing strength in time, as the gentleman remarked.

Vice-President Peterson:—When the question of putting blocks of stone in concrete came up, I would have liked to have said something, but the time is now late, and there are one or two points of more general interest which I would like to speak about, and that is the mixing of mortar in winter. It seems that

a good many of our members are afraid to lay masonry in winter. I live in a cold climate, where we have to do work when the temperature is at zero. I have mixed Portland cement concrete at zero, and put barrels of it on a bank of snow, and have tested it in the spring after the frost had gone out of it and found it set just as hard as stone. I have laid cement masonry in zero weather in four-foot walls, and in the spring have found that the cement has become just as hard as the stone. A little scale, about as thick as two or three sheets of paper, would scale off the outside, but in the inside of the wall the cement would be just as hard as stone. That is a thing that has been done, not only once, but twenty times. Since 1876 scarcely a winter passed that concrete work has not been going on somewhere on our railway; and in some special cases—in building elevator four-foot walls—it has been going on all winter.

Mr. Kittredge:—I would like to ask Mr. Peterson if he used any special proportions when he laid concrete in zero weather.

Vice-President Peterson:—No; in making tests I mixed the concrete with salt, and with cold water and cold stone; also with hot water and hot stone and hot sand, and with cold water, cold stone and cold sand—no salt—everything cold. These half-barrel samples were left out on a snow bank, and when examined in the spring after the frost was out of it I did not find any difference in these half-barrels of concrete. I found it just as difficult to break one as the other—all were very hard. Natural cements will not set at all in the winter time. I have no hesitation in using Portland cement in any kind of weather.

Mr. Abbott:—As a second to that I might mention a little experience we had in Cleveland in building the walls of the Jefferson Street bridge. We tried experiments there in winter with natural cement, and found salt water would not prevent disintegration, but with Portland cement—whether we used salt water or not—it set all right in cold weather, and we found that none of the natural cements we tried in cold weather would answer. Portland cement, on the other hand, we found was good when spring came, even if set in freezing weather.

Mr. Mountain:—I would like to ask Mr. Peterson if he thinks salt deteriorates from the cement itself oozing out in the mortar?

Vice-President Peterson:—I do not think so.

Mr. Lewis:—I think the proportion in which the concrete is made up largely determines whether weather affects it or not. If it is mixed in such a proportion that the cement has not enough tensile strength to resist the freezing of the water, it will spoil. You can make tests from neat cement, gradually mixing in sand and gravel, and you will easily find that there is a point beyond which any given cement will not stand freezing. If it is mixed up rich enough, Portland cement will resist all the freezing it can get in the winter. I think it is largely a matter of proportion. I have not been able to secure sufficient data to justify a positive statement to that effect, but I think it will usually be found that concrete which will stand freezing before setting has been mixed in a richer proportion than that which fails under like circumstances.

Mr. V. K. Hendricks (Terre Haute & Logansport, by letter):—In 1899 we used a body of natural cement concrete (Utica cement) mixed 1, 2 and 4, with three inches of Alpha Portland cement concrete 1, 2½ and 5 outside, and faced with one inch of mortar mixed 1 to 2, in a number of rail-top culverts and two track-scale foundations. None of this work has shown any signs of failure, and I think it will stand. Natural cement backing with Portland cement facing was used quite extensively on the Chicago drainage canal. I think the results of such a combination depend on certain relative properties of the cements used.

Mr. W. S. King (Union Stock Yards & Railroad Company, Omaha, by letter):—In mixing concrete, we do not adhere to any set rule for the proportions of cement, sand and stone, but regulate it so as to fill all voids possible. If the sand is coarse it will need more cement; if the stones are large and angular, we use less of them. The linings for the forms are made as smooth as possible, using a thick smooth paper against the boards, insuring a smooth surface if the concrete is dumped in properly.

Vice-President Peterson:—The next in order is the report of the Committee on Ties.

REPORT OF COMMITTEE III—ON TIES.

To The American Railway Engineering and Maintenance-of-Way Association:

For convenience in handling the subject of this report and on account of the wide geographical separation of the different members of the Committee, it was considered best by the Chairman to assign to each member of the Committee one of the subheads into which the general subject is divided for special consideration and report.

In addition to the subheads published in the outline of Committee work in the Proceedings of the First Annual Convention, an eighth has been added on "Statistics."

The assignments of subjects were:

1. Material: To Mr. W. L. Darling, Assistant Chief Engineer Northern Pacific Railroad.
2. Preservation: To Mr. O. Chanute, Consulting Engineer.
3. Inspection: To Mr. J. J. Frey, President Florence & Cripple Creek Railway.
4. Cost: To Mr. J. C. Nelson, Division Engineer New York Central Railroad.
5. Disposition of Old Ties: To Mr. Wm. Archer, Principal Assistant Engineer Baltimore & Ohio Southwestern Railroad.
6. Methods: To Mr. W. C. Cushing, Superintendent Pennsylvania Lines West, Pittsburg.
7. General Questions: To Mr. Lewis Kingman, Chief Engineer Mexican Central Railway.
8. Statistics: To Mr. G. W. Kittredge, Chief Engineer Cleveland, Cincinnati, Chicago & St. Louis Railway.

Two of these Sub-Committees made no report.

The following is made up from the reports of the individual members. In the case of Subject No. 2, "Preservation," and Subject No. 4, "Costs," the reports by Mr. O. Chanute and Mr. J. C. Nelson are given in full.

It is to be regretted that but little general interest seems to be taken among railroads in handling this important subject. One of the Committee wrote to 40 railroads, and received replies from 13 only.

The statistical information is rather meager, especially that pertaining to form 1-b, which is most important, but this is a beginning. It is to be hoped that all roads represented in this Association will see the importance to themselves and others of keeping up such information.

One correspondent comes to the conclusion that the white oak tie, being undeniably the best, it is not worth while to keep any record, and the difficulty involved in keeping a record of ties put in and removed from the track is to add to their expense.

1. MATERIAL.
   a. Wood—Various kinds.
   b. Metal—Shapes, etc.

Up to the present time, each railroad company has found it best and most economical to use in its tracks cross-ties made from those timbers which are nearest to its territory and therefore the most available and economical. The value of these woods is consequently pretty well known to the adjacent railroad companies at the present time. For instance, it is well known to the companies operating in the eastern, middle and some of the western states that a life of 8 and 9 years is obtained in main tracks for white oak ties, and that they are the best ties which they can obtain. The Canadian roads are restricted to the use of cedar and hemlock for the most part, the southern roads to yellow pine and the western roads to mountain pine and redwood.

The eastern and middle states roads are now finding that they are compelled to go farther each year to secure the valuable white oak ties and that at the same time, the price is steadily increasing, indicating a growing scarcity of the supply. They will therefore make inroads on the timbers considered less valuable for cross-ties, such as yellow pine, hemlock, cedar, tamarack, mountain pine and redwood, which additional consumption reduces the available supply for roads now using these timbers, and hence the tie question is becoming of importance to all the consumers.

A great deal of attention to the forestry of the tie question has been given in Europe, and as practice in Europe is very often the forerunner of what will ultimately be done in this country, the Government Division of Forestry is already doing valuable missionary work in that line.

The subject of metal ties has received so little attention in this country, and the cost as compared with wooden ties is so great, that this does not appear at present to be a live question.

2. PRESERVATION.

Consideration of Methods and Cost.

The report of Mr. O. Chanute, Sub-Committee on Preservation, is given below in full:

Ties of durable woods have hitherto been so abundant and cheap in the United States, that there has been little inducement to prolong their life by chemical preparation, a practice now uniformly prevailing in Europe. This fortunate American condition is passing away, and already some 3 or 4 per cent. of the 100,000,000 ties annually laid or renewed in this country are being chemically injected. This treatment is applied to the inferior woods which are still copious, and the practice will grow rapidly, as the economy is one of fast increasing importance. A number of sagacious railroads, to be more particularly noticed hereafter, have demonstrated during the last 15 years that success is possible, and the methods introduced are being still further improved.

The coming necessities are bringing forward a number of advertised processes for discussion and attention. These may be divided into two classes: 1st—External applications; 2d—Injections of chemicals under pressure. They will be discussed separately.

EXTERNAL APPLICATIONS.

There are a number of compositions which are being promoted, to be applied by painting or by soaking. They are chiefly used for framed timber and joints, but are also recommended for ties. It is recognized as essential to success that the wood should be well seasoned, so that the moisture and germs shall not be incased (a condition well known to produce quick decay), but that the composition shall soak in. When this is well done, good results have been reported for ties so treated, but it is probable that the success is due either to favorable exposures, or to the application of large quantities of the composition. Diligent enquiries have quite failed in procuring data as to the quantities absorbed by the ties whose long life is reported, and the amounts now recommended by the manufacturers of the products appear to be estimates.

Table No. 1 condenses the claims made for the principal external applications now in the market:

TABLE 1. Preservatives for painting or soaking.

Name.	Composition.	Price Per Gallon, Cents.	Quantity Per Tie, Gallons.	Cost Per Tie, Cents.	Life Claimed, Years.
Carbolineum Avenarius	Tar-Oil, Chlorine, etc...	80	¼	15 - 20	7 - 18
Ligni Salvor.....	Tar-Oil, etc.....	..	¼	.....	.....
Woodiline.....	Chemical Compound...	25	½	15 - 18	6 - 14
Spirittine	" "	25	½	12½	7 - 18
Wood Preservative.....	Distilled from pine, used by Penna. R. R. for car work.				

INJECTION OF CHEMICALS.

A good many different chemicals have been experimented with for preserving ties. Of these corrosive sublimate, sulphate of copper, chloride of zinc and creosote have proved their superiority over others, but the first two are now practically abandoned and only the latter two remain in extensive use.

Various modes of injection have been tested, such as soaking, boiling, vital suction, endwise application (Boucherie process) and pressure in closed retorts. Only the last mode now survives and this has been adopted by all the pioneer American railroads above alluded to.

The process generally consists in loading the ties upon special buggies, running these into a retort or cylinder some 6 feet in diameter and 100 to 115 feet long, closing this air tight, and then subjecting the ties to the following operations:

1st. Steaming at 20 pounds' pressure.....2 to 5 hours
2d. Vacuum from 18 to 26 inches mercury.....1 to 2 "
3d. Antiseptic solution, with 110 pounds' pressure.....2 to 5 "
4th. Subsequent solution, if any.....1 to 2 "
5th. Opening retort and recharging.....1 to ½ "

The whole process occupies from 6 to 12 hours as applied at different works. The quantities absorbed are ascertained by gauging the tanks

holding the solutions, and the actual weighing of the ties in and out is found at one plant to be an important check. The time occupied by treatment in Europe is about one-half of the above, in consequence of better prior seasoning of the ties.

Some tentative experiments at wood preserving were made by American railroads about 40 years ago, but timber was still too cheap to warrant their continuance. The methods and results were investigated by a committee of the American Society of Civil Engineers, and a report made to that society in 1885. By that time the price of the ties had so far advanced that preservation promised economy and it was again taken up.

The Atchison, Topeka & Santa Fe Railway took the lead in 1885. It adopted the "Wellhouse" or zinc-tannin process of injecting chloride of zinc, gelatin and tannin, the two latter substances being intended to retard the leaching out of the zinc. It built works at Las Vegas, N. M., and has there treated, at a current running cost of 15 to 18 cents each, some 4,000,000 of New Mexico mountain pine ties, which endure about four years untreated. It finds that the treated ties last 10½ years on its New Mexico division and 11 years on its Rio Grande division. It has now enlarged the original plant, has built another in Arizona, and has had large numbers of ties treated at a private plant in Texas. The officers are now engaged in investigating methods for doing still better work, as every additional year of life which can be given to a tie is worth at least five cents.

The Union Pacific Railway erected works for the "Wellhouse" process in 1886, and treated some 250,000 ties at a running cost of 18 cents each. Work was suspended in 1887 for reasons of temporary economy, the plant was partially burned and finally dismantled, but as some of the ties were still in the track in 1898, the road is understood to contemplate building another plant.

The next road to take up the subject was the Chicago, Rock Island & Pacific Railway. It preferred to contract with private parties in 1886 to erect and run works in Chicago on the "Wellhouse" process at a cost of about 16 cents a tie. It has had some 4,750,000 hemlock and tamarack ties treated, and its records show that the hemlock treated ties last 10½ years in its tracks east of the Missouri River and 11½ years west of it. The process was improved in 1896, and the results show that twice and a half as much chloride of zinc is now being injected as was done in the beginning. The same parties erected a plant in 1899 at Mt. Vernon, Ill., to treat ties for the Chicago & Eastern Illinois Railroad.

In 1887 the Southern Pacific Company leased the creosoting works of the Houston & Texas Central Railway, at Houston, Tex., and began "Burnettizing," or the injection of chloride of zinc by itself, without subsequent treatment. In 1891 it there built a plant of its own for this process. It has treated thus far about 2,500,000 pine ties, which would last about 4 years in their natural state, and finds that when treated the ties removed have lasted from 6 years and 11 months on the Glidden Division, where the rainfall is heavy, to 9 years and 2 months on the

Del Rio Division, which latter shows the best results. The average of the whole road is 8 years and 3 months, and the cost is uncommonly cheap, the running expenses (without interest or depreciation on plant) being reported at 6.44 cents per tie for 1898. The quantity of chloride of zinc injected is equivalent to about 0.24 pounds of the dry salt per cubic foot, or about one-half the standard injection in Europe, but it may prove adequate upon much of the arid regions occupied by the road. In any event, the management is so well satisfied with the results that it built another plant in 1894, making it portable, to operate alternately in California and in Oregon, and this has already treated some 2,500,000 ties.

This road has adopted from the beginning a system of records, much superior to that of any other road, and it is suggested that its methods be availed of so as to save the confusion which has ensued in other cases.

In 1897 a commercial plant was built by the Texas Tie & Lumber Company, at Somerville, Tex., which is working the "Wellhouse" process and in 1899 the Chicago, Burlington & Quincy Railroad built tie-treating works at Edgemont, S. D., which have been working ever since on "Burnettizing" proper.

Table II exhibits the particulars of these various plants and of some others which creosote or work other processes.

TABLE II. Principal Wood-Treating Plants.

Location.	Year Built	Owner.	Process.	Kind of Wood.	No. Retorts	Estim'td Capacity, Ties per annum.
Lowell, Mass....	1848	Locks & Canal Co....	Kyanizing....	Various ..	2	30,000
Las Vegas, N. M.	1885	A., T. & St. F. Ry....	Zinc-Tannin..	Pine, etc..	3	500,000
Bellemont, Ariz.	1898	"	"	"	2	350,000
Chicago, Ill.....	1886	C. Tie Preserving Co.	"	Hemlock .	4	500,000
Mt. Vernon, Ill..	1899	"	"	Black Oak	1	200,000
Houston, Tex ...	1891	So. Pacific Co.....	Burnettizing.	Pine, Fir & Spruce. etc.....	5	1,500,000
California.....	1894	"	"		2	1,000,000
Oakland, Cal....	1889	"	Creosoting ...		2	1,000,000
Edgemont, S. D..	1899	C., B. & Q. R. R.. ...	Burnettizing.	Pine, etc..	2	500,000
Somerville, Tex.	1897	T. Tie & Lumber Co..	Zinc-Tannin.	Pine, etc..	6	2,000,000
Beaumont, Tex.	1897	Int'l Creoso. & C. Co.	Various	Pine, etc..	1	500,000
P'rth Amb'y, N.J.	1890	Barschall Co.....	Hassellmann .	Pine, etc..	3	1,000,000
"	1895	U. S. Wood P'g.....	Creo. resinate	Pine, etc..	4	1,200,000
Brooklyn, N. Y..	1878	Eppinger & Russell..	Creosoting ...	Pine, etc..	4	800,000
Norfolk, Va.....	1896	N. Creosoting.....	"	Pine, etc..	4	900,000
W. Pascagoula..	1876	Lou. & Nash. R. R....	"	Pine, etc..	2	400,000

The estimated capacities are as stated by the parties and are given in ties which can be treated in a year, although the creosoting plants practically do none of this class of injection, but operate on piles and timber, upon which they do good work.

Creosoting is the standard mode of tie preservation in Europe. It is much the best, but is expensive. It costs there from 25 to 65 cents a tie, in accordance with the quantities injected, and would cost still more in this country, giving a life of 15 to 27 years in the track. American roads can hardly afford to apply this process to ties, costing, untreated,

about one-third as much as the European ties, but may be content with inferior processes. These are chiefly "Burnettizing" and "zinc-tannin," giving a life of 10 to 15 years, but there may be advantage in the "zinc-creosote" process, worked in Germany since 1874, which there costs 19.2 to 20.4 cents each for first-class ties, and is said to give them a life of 12 to 18 years.

It is to be expected that, having made much the same class of mistakes as the Europeans did in the beginning, i. e., imperfect work for lack of knowledge, we shall now gradually improve our practice and obtain better results than we have done. There is nevertheless a marked economy obtained by the pioneer roads. Let us take the Southern Pacific as an example. The untreated pine ties cost about 50 cents each when *laid in the track* in their natural state, and last some 4 years; this produces a charge of 12½ cents a year per tie, while if, when treated, they cost, say, 66 cents each when laid in the track, and last at least 8.25 years, they then produce an annual charge of 8 cents per tie. The economy will vary on different roads; on some there will be none at all. Some railways are able to obtain white oak ties costing 48 cents each in the track and lasting 8 years, or 6 cents a year per tie; others obtain cedar, cypress, or redwood, to cost, say, 66 cents each when laid, and lasting 11 years, thus again producing an annual charge of 6 cents a tie, but on many roads the durable woods are so far exhausted that they must resort to the inferior woods and treat them chemically to prolong their life. Each railway must consider the problem for itself, and the present report can only state general facts. The annual tie renewals vary greatly on different lines; data recently compiled by the "Texas Association of Superintendents of Railways" shows that the ties replaced on an average for 9 years in that state run all the way from 160 a year per mile for cypress, thus indicating a life of 16 years on a line 6.7 miles long, to 555 a year a mile for oak, or a life of about 5 years, on a line 192 miles long. The latter road pays 25 cents apiece at the distributing points, the ties thus costing about 45 cents each in the track, and it could probably afford to have them treated if it were assured as to the best process to use under its circumstances. We may now expect, during the next few years, to have a number of new processes brought forward, but it will take a long time to determine their efficiency.

Since receiving the above the Committee has received the results, up to date, of an interesting experiment in West Texas on a piece of new line built by the Southern Pacific Company in September, 1895.

It is well known that the action of chloride of zinc is to shorten the grain of timber, and many yellow pine ties treated with this preservative are removed from the track on account of shattering or separation of fibers long before decay sets in. This trouble forced itself on the attention of the officers, and it was decided to lay an experimental lot of yellow pine ties, impregnated with so small a quantity of creosote oil as to make the total cost of treatment reasonably small.

Accordingly, 1,694 sap pine ties, cut at East Texas mills, were impregnated with .68 of a gallon of creosote per cubic foot, or 1.8 gallons

per tie, at a total cost of treatment of about 19 cents per tie at the works. At the same time, about the same number of untreated pine ties of the same character were laid alongside the creosoted ones. At the beginning of this year, or after five years' and four months' service, not a single one of the creosoted ties had been removed from the track, whilst 292 of the common pine ties, or 16 per cent of the total number put in, had been taken out on account of decay.

If the thorough sterilization of the timber in the retorts and the subsequent injection of so small a quantity of oil as .68 of a gallon per cubic foot, which amounts to but little more than what might be termed a thorough soaking, will add materially to the life of ties at a cost of 19 or 20 cents, and if it will remove the objections of splintering, which, with the variety of pine in question, is one of the greatest objections to Burnettizing, as well as the trouble from the extreme solubility of the zinc salt, the experiment would seem to offer considerable promise of a solution of a serious problem.

3. INSPECTION.
   a. When purchasing.
   b. When necessary to renew in track.

It is necessary only to say as regards to inspection in purchasing that the inspector must be given no latitude as to the interpretation of the specifications, which should be so explicit as to leave no opening for a misunderstanding. In case of injustice on the part of the inspector, appeal should always be had to his superiors, and an adjustment made. Each tie must be turned over and examined by the inspector and so marked on the end that the mark cannot be changed or obliterated by the weather.

Inspection after removal for condemnation or re-use is most important and should be done by competent authority. The ties should be piled after removal in a neat and orderly manner for convenient inspection by the proper officer.

4. COST.
   a. Delivered at side of track.
   b. Loading.
   c. Transportation.
   d. Local distribution.
   e. Putting in track and spacing.

5. DISPOSITION OF OLD TIES.
   a. Method and cost of utilizing same.
   b. Use for firewood.
   c. Use for curbing, retaining walls and otherwise.
   d. Burning.

The almost universal practice is to collect and pile the ties as soon after removal from the track so as to present a neat appearance, as well as to permit the ties to dry for use as firewood, cribbing, etc., or for

COST OF UNTREATED CROSS-TIES.

Name of Road.	Size of Tie.	Kind of Wood.	Distance Hauled to Local Distributing Point.	Per Cent of 2d-Class Ties Used.	Cost Delivered at Side of Track.	Cost per Tie for Loading on Cars.	Cost per Tie for 100 Miles Hauled.	Cost for Local Distribution.	Cost for Putting in Track Ordinary Renewals.	Total Cost per Tie in Track.	
S. P. Ry.	7 in. x 8 in. x 8 ft.	Red Wood	225	40	.38¼	.01	.01	.00½	.10½	.52½	
M. C. R. R.	6 in. x 10 in. x 8 ft.	Oak	50	13	.45	.01½	.04¾	.01	.10	.60	
"	6 in. x 10 in. x 8 ft.	Cedar	50	13	.40	.01½	.02½	.01	.10	.53¾	
Wabash R. R.	6 in. x 8 in. x 8 ft.	Oak	46	11	.40	.01½	.05	.01	.10	.55	
N.Y.C. & H.R.R.R.	6 in. x 9 in. x 8 ft.	Y. Pine	150	10	.59	.01½	.04	.01	.10	.77½	
P. & R. R. R.	7 in. x 7 in x 8½ ft.	Y. Pine		20	.65	.01½			.15	.81½	All obtained locally.
"	7 in. x 7 in. x 8½ ft.	Chestnut		20	.45	.01½			.15	.61½	" " "
L. & N. R. R.	7 in. x 9 in. x 8½ ft.	Oak			.45	.01½		.01	.10	.57½	" " "
"	7 in. x 9 in. x 8½ ft.	Y. Pine			.23	.01½		.01	.10	.35½	" " "
B. & A. R. R.	7 in. x 7 in x 8 ft.	Y. Pine & Chest.	100	52	.55	.01	.06	.01	.14	.77	
D. & R. G. R. R.	7 in. x 7 in. x 8 ft.	Red Spruce	100	5	.33	.01	.00½	.01	.01½	.37	
Mo. Pac. Ry.	6 in. x 8 in. x 8 ft.	Oak	8		.32	.01½	.05	.00½	.06½	.40½	
L. S. & M. S. Ry.	7 in. x 10 in. x 8½ ft.	Oak	125		.58		.03⅓	.01	.11½	.74⅙	
P., F. W. & C. Ry.	7 in. x 8 in x 8½ ft.	Oak	175	25	.55			.01½	.15	.71½	
C. P. Ry.	6½ in. x 8 in. x 8 ft.	Cedar	50	10	.23	.01	.04	.02	.09	.37	
U. P. Ry.	7 in. x 7 in. x 8 ft.	Fir	300	1	.50		.01⅓	.01½	.10	.65½	
"	6 in. x 8 in. x 8 ft.	Oak	230	3	.56		.017	.01½	.10	.71½	
"	8 in. x 8 in. x 8 ft.	Wyo. Pine	200	5	.40		.02¼	.02	.11	.57½	
"	7 in. x 8 in. x 8 ft.	Cedar	250	5	.56		.016	.01½	.10	.71½	

burning on the ground. As a rule, it has been found unprofitable to collect and haul old ties to be used as fuel for locomotives, etc. At times and in localities where fuel is scarce, the section men are permitted to use a portion of the discarded ties for fuel.

On some roads old ties are used for fence-posts.

For temporary repairs of slips by cribbing and of small wash-outs the old ties will take the place of more valuable material, and where the character of the road is such that a demand for repair material is frequently made, a stock of old ties kept in neat piles at convenient intervals should be maintained.

At all large freight houses a few carloads can be used each season for blocking and securing certain classes of freight on the cars.

Partly worn-out ties which are taken out during repairs, and will not last long enough in main-line service to pay for putting back, may be advantageously used in unimportant sidings or spurs.

The method adopted by one of the roads is to have all ties removed from track classified under two heads, viz.: "Good old ties" and "Fuel ties." These are piled by the section foreman to the best of his judgment, in accordance with Fig. 1. The ties so classified are inspected carefully by the roadmaster, division engineer, and, as the opportunity offers, by the engineer of maintenance-of-way, so as to make sure that no "Good old ties"—that is, ties suitable for use in sidings, for fences or other purposes—have been classified as "Fuel ties," and that no ties have been removed from track from which a longer use could be obtained. The effect of this rigid inspection has been to materially reduce the number of good ties removed from track and to bring about a very considerable economy in maintenance.

6. METHODS.

a. Handling tie question.
b. Reports and accounts.

The employment of preserved ties is now increasing, and it should be the work of this Committee to keep track of what is being done by the members of the Association, collect their results and tabulate them each year for the benefit of the whole membership. In this way we will always have available the full information concerning preserved ties brought up to date. But to do this the Committee must in future have the support and assistance of the various roads when called for.

A suitable blank for the reports from the different members of the Association to the Committee is necessary, and one is submitted herewith under the subhead "Statistics."

In order that accurate information concerning the life of ties may be kept, each tie may be marked with a copper or galvanized iron nail, with the date, in two figures, stamped on the head. On one road cast-iron dating hammers are used. These have the date cast on one face in raised numbers, and the ties are stamped on the "lined-up" ends by striking them a smart blow with a hammer. The hammers cost a trifle

and are scrapped at the end of the current year. When any ties so marked are removed from the track they should be reported through the regular channels to the division engineer.

A uniform set of specifications for present use would be a benefit both to the railroad companies and to the tiemakers. As it is now, where different railroad companies purchase ties in the same territory, it is customary for several inspectors to go over the same lot of ties, each picking out ties which come nearest to his specifications, which leads to a great variety of classes of ties and creates trouble for all concerned.

7. GENERAL QUESTIONS.

a. Preparing for track.
b. Piling for use.
c. Boring for spikes.
d. Planing and adzing for tie-plates.
e. Lining up on ends.
f. Marking for age in service.
g. Tie-plates.

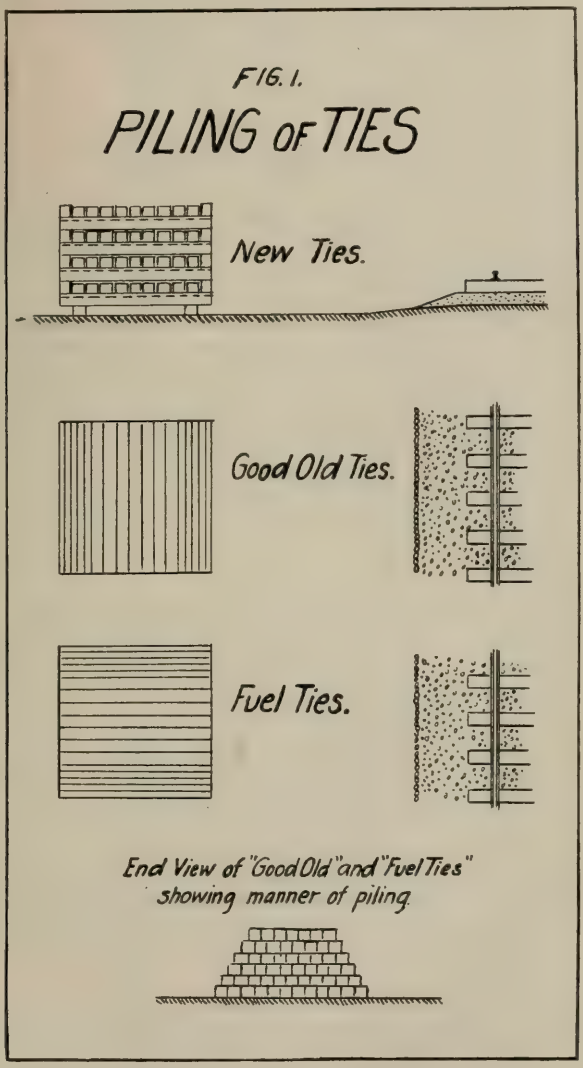
In renewing ties, if there is any irregularity in size, the larger ones should be placed under the joints. Holes left in serviceable ties when spikes are drawn should always be plugged with wooden plugs.

New ties carried in stock for use should be piled with spaces of an inch between them, so as to allow the free circulation of air. This can be best accomplished by placing the ties alternately parallel with and perpendicular to the line of track, the end ties in the pile being turned up on their edge. This allows for the circulation of air. Old ties should be gathered at the end of each day's work and neatly piled for loading on cars. Those classified to be again used in sidings or other tracks should be piled parallel with the rails; those to be used for fence-posts and fuel should be piled at right angles to the rails. The fuel ties should be promptly removed to fuel stations. Ties entirely useless should be condemned by the roadmaster and burned promptly on their removal from track. Ties misplaced by trespassers should be promptly repiled.

It is not customary in this country to bore ties for spikes, and it is difficult to see how it can be done to advantage. About the only case in which such boring is recommended is when the ties are preserved by the "Wellhouse" process or by creosote, which requires that the surface should be left intact. In this case boring for spikes might be done before treatment, but a difference in the base of rail, spread of rails on curves and other difficulties make the advantage of this questionable.

Where tie-plates are used no adzing of ties under them should be permitted except such as may be absolutely necessary to make a flat and even bearing for the tie-plates on split and hewed ties. Such adzing should be done with care to avoid waste of timber. Ties should not be adzed to give the tie-plates a bevel. Where tie-plates are not used, no adzing of the ties under the rail should be permitted, except such as is necessary for "straightening up" rail which has rolled; in such cases

roadmasters should supervise the work carefully to make sure that the wood is not cut down beyond an absolutely necessary depth.



On single track, ends of ties should be perfectly lined on one side of the track throughout; on double track, the outer ends of ties should be lined. On 8-foot ties, the gauge notch should be cut on spike maul

handles, 16½ inches from the end, and for 9-foot ties, 22½ inches from the end. In laying track or replacing ties, the end of the handle of the maul should be placed against the outer edge of the rail base, and the ends of the ties drawn to the notch. When ties are sawed or hewn out of square their extreme ends should be brought to line.

Marking for age and service has already been reported on in subdivision 6.

Tie-plates have now become a well-established article of manufacture. Those principally in use consist of flat-rolled steel, with ribs and surfaces of various forms. Their utility for saving soft ties is so well established that it seems superfluous to report in favor of their use. In setting tie-plates, they should be set squarely upon the ties and be firmly imbedded in them, so as to place the bottom of the tie-plates exactly flush with the tops of the ties. They should not be left partly driven, with a view of having them forced down by the weight of a train. Where tie-plates are punched for more than one section of rail, care should be taken to place the plates on the ties with the gauge side of plate corresponding with the gauge side of rail. This is important for the reason that unless it is followed heavy rail cannot be laid to replace lighter sections without removing the tie-plates. For the convenience of sectionmen the shape of the hole punched on the side next to the flange of rail and on the gauge side of plate should be indicative of the weight of the rail to be used.

8. STATISTICS.

The accompanying forms, 1, 1a and 1b, embody the statistical information so far received from the various railroads corresponded with.

The purpose of form 1 and 1a seems to have been generally understood, but form 1b has been correctly filled out by one company only.

Most of the roads applied to for information to be contained in these forms declined to answer, some upon the ground that their accounts are not so kept that they can reply to them, and some that it was too much trouble and labor to supply the information.

In conclusion, your Committee desires to say that this report is very imperfect and not at all satisfactory to them, but it is to be hoped that it will assist in awakening sufficient interest in this subject to enable more complete data to be collected in time for the next report, and, as above stated, this is a beginning of a collection of valuable information which will take much time to complete.

Respectfully submitted,

J. KRUTTSCHNITT, Fourth Vice-President and General Manager Southern Pacific Company, San Francisco, *Chairman;*

G. W. KITTREDGE, Chief Engineer Cleveland, Cincinnati, Chicago & St. Louis Railway, Cincinnati, *Vice-Chairman;*

O. CHANUTE, Consulting Engineer, Chicago;

J. J. FREY, President Florence & Cripple Creek Railroad, Denver, Colo.;

Form 1.

Name of Railroad.	Miles of Main Track.	Average Cost of Ties at Distributing Point.		Total Cost of Renewals.	
	First Main Track.	Treated Ties.	Untreated Ties.	Per Mile First Main Track.	Per Mile of All Tracks.
1	2	18	19	20	21
Bangor & Aroostook	354	.....	$0.27	.....	No record.
C., I. & L	508.8	.....	.48 1st c .31 2d c	.....	.....
C. Jct. R'y	86.2	.....	.58¾	.....	.....
C.,M. & S. P. R'y (a part of)					
C. & M. Div. 15% cedar	83	.....	.55	$153.23	$152.34
River Div. 25% cedar	166	.....	.65	180.64	175.44
Pr. du C. Div. 20% cedar	223	.....	.45	115.00	111.36
Ia. & Dak. Div. 85% cedar	553	.....	.50	110.48	109.00
James R. Div. 100% cedar	317	.....	.60	99.80	98.00
D., L. & W	516	.....	Av. .49	.....	Av., 114.17
Evansville & Terre Haute	103.5	.....	.42	.....	35,653.60
Humeston & Shen'd'h R'y	95.4	.....	.62.6	.....	231.68
Indiana, Illinois & Iowa	228.1	.....	.....	95.50	84.30
Long Island Railroad	379.5	.....	.47	188.40	116.00
Maine Central	815.8	.....	.27	.....	100.48
Manitoba & Northwestern	249.9	.....	.29.1	146.76	133.17
Michigan Central	1,641.9	.....	Oak.46.25 Ced..33	.....	.....
Missouri, Kansas & Texas	1,988	.....	.37	.....	133.00
N., C. & St. L	1,195.3	.....	.27	122.06	101.46
N. Y. C. & H. R. R. R.	2,961.0	$1.31	.53	.....	.....
Norfolk & Southern	146.8	.....	.38.3	65.75	68.39
Norfolk & Western	1,554.6	.....	.35	1,004.00	738.20
Pa. Lines (Louisville Div.)	216.3	.....	.38.6	134.41	105.06
Pa. & Northwestern	76.5	.....	.41.6	306.22	164.75
S. Fe, Prescott & Phœnix	126	.....	.35.5	180.76	156.88
Seaboard Air Line	1,048.9	.....	Oak.32.13 Pine21.87	Not sep	72.00
Southern Indiana	147	.....	.27	.....	.....
S. P. Co. (Pac. System)	5,155.8	.35	.35	180 23	143.57
S. P. Co. (Atl. System)	1,929.6	.33⅓	.36¾	147.30	117.18
Vand'a Line(T.H.&I.R.R.)	620.9	.....	.40	154.42	109.80
Texas Midland	125	.....	.28	112.18	110.20
Wisconsin Central	783.5	.....	.28	109.34	88.52
Clev., Lorain & Wheeling	192.3	.....	.....	421.65	330.00
Illinois Central	3,995.8	.....	.35 1st c .23 2d c	136.14	94.02
*Wab. R. R. (Detroit Div.)	242	.....	.45	204.90	142.50
Burlington's Mo. Lines	1,000	.....	4.25	181.32	141.06
Pittsb'g Div.C.,C.C,& St.L.	246.5	.....	52.58	.....	278.85
Total,	30,078.8				

*To include cost of cross and
Use mileage in column 2 fo
Use mileage in column 4 fo

UNTREATED TIES

Name of Railroad	White Oak		Pine						Total	Treated Ties: Creosoted	Burnett Yard	Total	Grand Total	Per cent of Removals to Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Baltimore & Ashburton														
Total														
Cumberland Valley														
Western Railroad of														
Baltimore & Ohio Railroad														
Seaboard Air Line														
Central Railroad &														
Georgia Railroad &														
Atlanta & West Point														
Western Railway of														
Louisville & Nashville														
Mobile & Ohio														
Illinois Central														
Yazoo & Mississippi														
New Orleans & Northeastern														
Vicksburg, Shreveport &														
Louisville & Nashville														
Nashville, Chattanooga &														
Cincinnati, New Orleans &														
Alabama Great Southern														
New Orleans & Northeastern														
Total														
Chicago, Rock Island &														
Chicago, Rock Island &														
Total														
Kansas City, Mexico &														
Texas & Pacific														
Missouri Pacific														
International & Great														
Missouri, Kansas &														
Texas of Texas														
Total														
Chicago & Alton														
Illinois Central														
Louisville, Henderson &														
Louisville & Nashville														
Mobile & Ohio														
Nashville, Chattanooga &														
Total														
Chicago & Eastern														
Chicago, Indianapolis &														
Louisville & Nashville														
Total														
Chicago, Milwaukee &														
Chicago & Northwestern														
Chicago, St. Paul,														
Minneapolis & Omaha														
Wisconsin Central														
Total														
Duluth, South Shore &														
Total														

TOTAL TIES IN TRACK

Name of Railroad	Untreated Ties: White Oak		Pine						Total	Treated Ties: Creosoted	Burnett Yard	Total	Grand Total	Per cent of Removals to Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Baltimore & Ashburton														
Total														
Cumberland Valley														
Western Railroad of														
Baltimore & Ohio Railroad														
Seaboard Air Line														
Central Railroad &														
Georgia Railroad &														
Atlanta & West Point														
Western Railway of														
Louisville & Nashville														
Mobile & Ohio														
Illinois Central														
Yazoo & Mississippi														
New Orleans & Northeastern														
Vicksburg, Shreveport &														
Louisville & Nashville														
Nashville, Chattanooga &														
Cincinnati, New Orleans &														
Alabama Great Southern														
New Orleans & Northeastern														
Total														
Chicago, Rock Island &														
Chicago, Rock Island &														
Total														
Kansas City, Mexico &														
Texas & Pacific														
Missouri Pacific														
International & Great														
Missouri, Kansas &														
Texas of Texas														
Total														
Chicago & Alton														
Illinois Central														
Louisville, Henderson &														
Louisville & Nashville														
Mobile & Ohio														
Nashville, Chattanooga &														
Total														
Chicago & Eastern														
Chicago, Indianapolis &														
Louisville & Nashville														
Total														
Chicago, Milwaukee &														
Chicago & Northwestern														
Chicago, St. Paul,														
Minneapolis & Omaha														
Wisconsin Central														
Total														
Duluth, South Shore &														
Total														

PER CENT OF REMOVALS TO TOTAL

Name of Railroad	Untreated Ties: White Oak								Treated Ties				Grand Total	Per cent of Removals to Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Baltimore & Ashburton														
Total														
Cumberland Valley														
Western Railroad of														
Baltimore & Ohio Railroad														
Seaboard Air Line														
Central Railroad &														
Georgia Railroad &														
Atlanta & West Point														
Western Railway of														
Louisville & Nashville														
Mobile & Ohio														
Illinois Central														
Yazoo & Mississippi														
New Orleans & Northeastern														
Vicksburg, Shreveport &														
Louisville & Nashville														
Nashville, Chattanooga &														
Cincinnati, New Orleans &														
Alabama Great Southern														
New Orleans & Northeastern														
Total														
Chicago, Rock Island &														
Chicago, Rock Island &														
Total														
Kansas City, Mexico &														
Texas & Pacific														
Missouri Pacific														
International & Great														
Missouri, Kansas &														
Texas of Texas														
Total														
Chicago & Alton														
Illinois Central														
Louisville, Henderson &														
Louisville & Nashville														
Mobile & Ohio														
Nashville, Chattanooga &														
Total														
Chicago & Eastern														
Chicago, Indianapolis &														
Louisville & Nashville														
Total														
Chicago, Milwaukee &														
Chicago & Northwestern														
Chicago, St. Paul,														
Minneapolis & Omaha														
Wisconsin Central														
Total														
Duluth, South Shore &														
Total														

Form 1b

LIFE RECORD OF TIES.

LIFE RECORD OF TIES

Name of Railroad	Number of Ties Laid During Year													
1	1888 2	1889 3	1890 4	1891 5	1892 6	1893 7	1894 8	1895 9	1896 10	1897 11	1898 12	1899 13	1900 14	1901 15
*Bangor & Aroostook						17 112	16 739	19 222	32 980	38 859	37 484	33 644	50 209	
Connecticut Lake & Atlantic						61 217	10 737	62 380	114 942	940 071	91 410	125 461	179 814	
Eastern & Lower Hudson					18 168	83 054	77 189	56 046	57 886	52 364	38 922	49 070	65 301	
Fitchburg & Worcester							134 472	1 742	3 670	21 951	84 103	82 982	31 482	
Indiana, Indiana & Iowa						31 762	11 084	58 769	47 630	51 642	42 900	43 904	19 680	
Maine Central R.R.	28 467	51 88	41 384	115 451	281 675	181 816	146 458	200 829	261 948	530 740	551 040	474 459		
Montreal & Boston R.R.	428 [illegible]	413 78	511 068	623 617	727 804	523 698	791 241	392 885	646 085	735 994	576 548	737 083	658 846	
*New York, N.H. & Hartford								102 111	348 346	471 109	505 186	128 910	372 584	
Pittsburg, Cin. & Kentucky R.R.	134 [illegible]	1 [illegible]	665 505	508 567	455 [illegible]	632 556	512 428	596 809	537 432	513 914	554 536	512 591	761 135	
Salina, Dr. P. & C. P. & E.					34 000	126 000	50 000	150 000			78 000			
*Saco, Dr. Pt. & C. Short	14 [illegible]	8 385	21 677	180 [illegible]	247 179	179 259	180 768	100 502	165 783	86 737	152 322	247 560	342 335	
*Saco, Dr. Pt. & C. Ry. Sys.							81 873	433 139	475 108	478 721	631 [illegible]	630 830		
T. H. & I. Northwestern Line	[illegible] 21	95 46	284 084	500 450	554 454	1 242 227	203 125	430 848	256 901	257 301	240 756	166 163	237 157	
Terre Haute & Logansport	2 [illegible] 28	91 109	65 [illegible]	71 41	91 872	48 532	58 306	57 235	61 820	61 433	57 201	14 809	71 805	
							New Rd 81 000		New Rd 152 000					
Texas Midland														
Union Pacific											676 919	836 582	894 108	
*Wabash, Detroit & Detroit					500 00				1 876	10 860	25 406	21 847	117 030	
Wisconsin Central							207 041	483 602	571 188	313 510	383 101	249 116	316 226	

* The mileage of the Bangor & Aroostook, No. Conway, Me., Saco & No. Scot., No. Berwick, Me., No. H. R.R. 1 No. 12 355 2 No. 13 478 1 No. 14 122 1, all including sidings. For the year 1897 the mileage of the Saco & Pt. Short Line and the Saco, Dr. Pt. & C. Ry. Co. decreased because of the renewals of [illegible] No. 1 [illegible] 1897 [illegible] the mileage affected. †

The [illegible] of the Maine Central R.R. Co. is [illegible] to that it can be fairly represented by the number of removed

No [illegible] was kept [illegible] 1892 [illegible] Moses Burpee, Chief Engineer.

‡Replies to the questions I sent out from [illegible] Engineers of the railroads [illegible] and during the years 1895 to 1900 inclusive. I presume an equivalent number of the [illegible] the eight years. The data were [illegible] the engineers of the operating department, and I have no means of obtaining much data on the subject. I suggest however that the best way for the purposes [illegible] is to take ties and that we only so far have used two classes of timber, Oregon Fir and Eucalyptus.

W. H. Kennedy, Chief Engineer.

[illegible]

[illegible]

*[illegible]

[illegible]

[illegible]

J. C. Nelson, Division Engineer New York Central & Hudson River Railroad, New York;
W. L. Darling, Assistant Chief Engineer Northern Pacific, St. Paul, Minn.;
William Archer, Principal Assistant Engineer Baltimore & Ohio Southwestern Railroad, Cincinnati, Ohio;
W. C. Cushing, Superintendent Pennsylvania Lines West, Pittsburg;
Lewis Kingman, Chief Engineer Mexican Central Railway, Mexico, Mex.;
Committee.

Mr. G. W. Kittredge (Cleveland, Cincinnati, Chicago & St. Louis):—I have very little to say in regard to the report of the Committee on Ties, which is in your hands. Circumstances have been such that I was unavoidably absent during the greater portion of the time given to the consideration of this report, and the actual preparation of it did not devolve upon me. However, such as it is, it is a report of progress, and we hope before another meeting that the different members will show more interest in answering the questions sent to them than they have shown at this time. I appreciate from my own office, and my own personal experience, that it is difficult to get all the information that a committee desires, but I am sure that better results and a better report could have been made in some particulars had all of the members taken the interest that some of them apparently did in giving us answers. It was particularly hard to get any information in regard to statistics. I think less than one-third of the people responded with any information that could be used in the report.

Vice-President Peterson then introduced Dr. Hermann Von Schrenk, Instructor in the Shaw School of Botany, St. Louis, in charge of investigation of timber diseases for the United States Department of Agriculture, who read the following paper:

Mr. President and Gentlemen:—Because of the brief time allotted me, I shall make no attempt to discuss at length the decay of timber, but will present in brief some of the results of recent work on this subject, with particular reference to the decay of ties and bridge timbers, touching upon the method hitherto adopted to prevent such decay with some recommendations as to what ought to be done in the future.

The idea that wood decay is due to some process of oxydation or fermentation is one which has given way to a better understanding of this process. We now know that decay is due to the growth and activities of a number of low plants called fungi, the fruiting bodies of which are the familiar toadstools found on living and structural timber, examples of

which you see before you. Their life history and mode of action, while growing on live, as well as on dead timber, may be briefly summed up as follows: One or more of the very minute spores of one of these fungi sprouts or germinates on a piece of wood; the fine thread enters a wood cell and soon gives off a complex chemical compound, known technically as a ferment or enzyme, which dissolves certain parts of the material which constitutes wood fiber. The dissolved products serve as a food supply for this young plant, and may be roughly compared to the substances which a tree draws from the soil and air, or more to a plant like the mistletoe, which takes its food from the branch of the oak tree on which it grows. The first thread branches and rebranches, and before long a mass of fine threads extends throughout the piece of infected wood. The growing parts of all these threads give off the ferment spoken of, and as a result all those parts of the wood reached by the threads have certain products removed from the walls of the wood fibers. The removal of these products changes the chemical and physical properties of the wood, so that in some cases it turns dark brown, and when dry is like brown charcoal, in other cases it is white, soft and stringy. We then say that the wood is rotten, or that it has decayed.

Jumping now over a considerable period of time, we find that after sufficient material has been appropriated by the fungus threads, that some of these threads grow out from the surface of the affected wood, forming various kinds of hard lumps or sometimes shelves (the toadstools referred to) on the under side of which one finds holes or cavities. When examined under the microscope these cavities are found to contain thousands of spores, which are discharged into the air when ripe, and float off, settling on sound pieces of wood, where they may germinate and go through the same process just described.

A word as to the conditions which favor the germination and growth of these fungi. Moisture is the most important requisite, for without water the fungus cannot grow. For this reason the ties in a well-drained roadbed will last longer than those in a poorly-drained one. Heat is another factor. Growth, and consequently decay, go on faster in warm weather than in cold weather. Wood which contains starches, sugars or oils in some of its cells, that is, sapwood, offers a more abundant food supply than the heartwood, which has none of these products.

The point I wish to call particular attention to and to emphasize is the fact that wood of itself will not rot or decay. It may be kept for 25 years or more (and this has been done) without decaying. Well-known instances of this kind may be found in buried timber, where the conditions are such that fungi cannot grow. From the foregoing you will understand that all decay proceeds from without inward in wood like a tie (except where boring insects allow spores to penetrate into the interior of the wood); furthermore, that the appearance of the fruiting bodies of fungi on a piece of wood is always an indication that the wood is already decayed.

To sum up: Decay is a chemical process induced by ferments given off by the threads of low plants growing in the wood.

We come now to the consideration of the all-important question: How can the growth of these plants be prevented? This may be done either by keeping away the fungus or by bringing about conditions in the wood which will not allow of the development of the fungus. The first cannot be accomplished entirely, but much can be done by avoiding the accumulation of dead wood along the right-of-way, particularly of decayed ties, so that the formation of fruiting bodies may be prevented; furthermore, by discouraging wasteful lumbering methods, for it must not be forgotten that all these wood-destroying fungi come from the forests, and the more dead wood there is near the track, the more spores will be formed. I wish that the time allowed of my enlarging on this phase of the forestry problem, but I can do no more now than to bring it to your attention. The railroads can do much toward establishing a healthy forest policy, by which they will be affected as much as any portion of our communities.

The more feasible and sure way of preventing decay has been found to be by injecting the wood with various chemical substances. In Europe the practice of injecting wood has been in use for some time, but for reasons, intelligible enough, it has not been generally accepted in this country. Now that the supply of available tie material is not so large as it was some years ago, the subject of wood treatment is receiving more attention from some railroads, and it can be predicted with safety that in the near future all roads with few exceptions will have to consider this problem. One need only read such statements as follows, which I quote from a leading lumber journal, to realize the truth of this prediction: "If the truth about it were known, very likely it would show that in proportion to the demand, the oak supply is about the smallest of any of the important woods. . . . It becomes an interesting question how long the South —the only real oak-producing district left—will sustain the increased drafts on its resources."

Several problems at once confront the engineer when he considers the question of treating ties and timbers. There are many processes of treatment in use, and he naturally asks: Which shall I use, and what is it going to do? Anyone who has read the published accounts of experiences given by engineers and others who have written on this subject for the past 25 years will be impressed with the hopeless contradiction and unsatisfactory evidence which he finds there. The experience of one man with one system is entirely different from that of his eastern associate with the same system, not to speak at all of different systems of treatment. No two kinds of treatment have ever been tried side by side for any length of time, and of none is it positively known for exactly how long they will prevent decay.

I do not wish to discuss here the merits or demerits of any or all the impregnating systems used, for any opinion would have to be based on purely a priori grounds or laboratory tests. These may be exceedingly valuable as indicating what may be expected, but they by no means furnish a positive proof one way or the other. The testimony of the men operating

a system may be valuable, but it is always open to suspicion as coming from an interested party. What I wish to present for your consideration are some suggestions, which in my opinion will be the only way of satisfactorily arriving at any definite results which can be trusted.

The greatest difficulty in determining upon a system of treatment is the fact that one must wait fifteen or twenty years before being able to determine the relative values of the various systems. The question has been asked by chemists and engineers, Is it not possible to accelerate the action of these fungi in some way so that they may bring about the decay of eighteen years in three or four years? This question may be answered in the negative, with a qualification. The reason why an impregnated tie will last eighteen years is to be found in the fact that the salt, which stops the growth of the fungus, remains in the wood unchanged in composition, and in sufficient amounts to inhibit growth for that length of time. If we can determine how many years it will take before the amount of salt falls to the minimum which will allow growth of the fungus, we can then, by adding on the lasting time of unprotected wood, predict how long such a tie will last. Such a determination can be made only by actual examination of thousands of ties in the roadbed for a series of years, for the retrogressive changes which take place in a tie, at least so far as the decay is concerned, are changes which take place in the chemical composition and the amount of the injected salt, and both can readily be determined chemically.

It would, as you will readily see, do no good to cause the fungus to manufacture "more ferment" even if this were possible. An investigation of the changes in the roadbed, while most desirable, and one which ought to be carried on from now on, I consider as of secondary importance to an actual determination of the value of an impregnating system from the study of treated ties in the roadbed. Such a determination will have to be made sooner or later; all records of treating so far made are in this direction, only they are one-sided. I wish to ask your attention for a few moments to a simple way in which this can be done.

From actual experience we know that ties decay faster in certain sections of the United States than in others. In regions which have a high annual rainfall decay is very rapid, especially in the Southern States. Oak ties, which ordinarily last on an average eight or ten years, decay in three years or less. The same is true of pine ties, only more so. You have before you samples of ties from such localities. This is a white-oak tie from Northern Maryland, which had been in a cinder-ballasted track three years. You will note the effect of the fungus on the wood. In this piece the lower part of the tie looks wet. When placed in the most favorable conditions the fungus threads grow out from the wood cells and then you have this other appearance. Here is a piece of loblolly pine from Southern Texas, which had been in the track not quite three years.

It is to be assumed that localities such as these will be the most unfavorable to the preservation of wood and that any changes which would take place in preserved wood will take place most rapidly there. The plan which I would propose is, therefore, to find first of all regions as described

in all parts of the country, as many as may be feasible, to have several thousand ties, each treated by the various preserving processes in use, and to place these ties in the roadbed in these localities in such a way that the ties of one kind shall be mixed in with the others, and also with some untreated ties. The ties should be marked in such a way that they may be distinguished for fifteen to twenty years. Examinations of a chemical and biological nature should then be made every year by trained men. Such examination ought to show in a few years which of the processes is the most superior one for that short period, and from the data obtained in that way predictions could be made with more certainty for longer periods of time. If the time permitted I would like to explain more in detail the character of these examinations. Some engineers now say that all they want is to determine the value of one system; well, suppose after four or five years they find it unreliable. Try another; good, but that is five years lost and much money wasted. I might add here that if such an experiment were made, I would favor doing it on a large scale. The railroads would have to furnish the ties and the track to put them in. I have been assured by the prominent treating companies that they will treat all ties for such an experiment.

In this connection I wish to say a word about record keeping. As now conducted, it is most unsatisfactory. I can see that an accurate record of what becomes of the treated ties will in the future be information of the greatest value. Recently, thanks to the efforts of one of your members, a beginning has been made by labeling the tie with stamped nails. These in my opinion ought to be put in the top of the tie between the rails so as to be easily visible. As now practiced they are put into the ends, the place where they will soonest drop out in case decay sets in, as it does in the end very frequently. The nails could be put in by the section men, and this would have the further advantage, in that such a record ought to be of the time when the ties are laid, rather than when treated. The practice of stamping the ends of ties cannot be too strongly condemned, for marks in the wood cannot be recognized with certainty after four or five years.

Referring now to the plan which I have briefly presented, I would like to see this association take some action in that direction. A number of roads are now putting in many miles of ties treated by one process or another. They could just as well put in some treated by other processes and thus gain valuable data. I might say that we would be glad to be kept informed of any such experiment so as to make examinations of such ties, provided this seemed desirable to the railroad companies. I judge you will understand the value of examination of ties that come out of the track, for one reason or another, a feature which up to date has not been looked into.

The above suggestions are made in the firm belief that the time has come when it is desirable to look into the matter of tie preserving thoroughly. A single railroad can do much, but it is obvious that experiments carried on over the whole country on a large scale as outlined, by an unbiased authority, will be of far greater value and have greater weight. These experiments ought to be started at once, as every year is so much

time wasted. In conclusion, allow me to assure you that it will be our endeavor to co-operate with you in this matter as far as may be possible. I thank you for your kind attention.

Mr. F. T. Hatch (Vandalia Line):—One thing in the professor's paper struck me very forcibly; that is the gathering up of the dead wood. I don't suppose any of us thought the dead wood would have anything to do with the decaying of our ties. We gather it up sometimes for the sake of looks. If we look to that for the sake of preserving our ties I think we will accomplish something.

Dr. Von Schrenk:—We looked into this question of the rotting of ties in Washington this summer, and a section man assured me they were always careful to pile decayed ties in neat piles for the looks of things. I demonstrated the fact to him that that was the very best way for millions of spores to form in the ties. Wood, once cut from a tree, particularly woods that are generally used for tie purposes, with the exception of a small group of trees, will not resist the action of fungi at all. The only group of trees from which timber can be cut which will resist the decay are the trees that are grouped around the red woods—the spruce and the red cedar and the arbor vitæ, largely used for telegraph poles, and from which ties are made in Northern Idaho, Oregon and Washington; with the exception of these woods, all the timber which comes from trees such as oak, pine and beech, and the broad-leaf trees, will all be attacked just as soon as you put a fungus in them. We can take a spore that will sprout on a piece of timber and predict that it will be decayed.

Mr. W. W. Curtis (Consulting Engineer):—For the encouragement of the Committee in their attempts to get some information, I want to read a little clipping which was sent to me by a friend a year or two ago, who knew I was largely interested in the subject. When newspaper paragraphers get to work on a subject there is some hope for it: "The ties on the Santa Fe road are pickled in a solution of chloride of salt and zinc. There are three or four big pickling establishments along the road between Albuquerque and Los Angeles. The process makes a pine tie immortal." [Laughter.]

Last year I had the pleasure of presenting to the members of this Association copies of a paper of mine which had been

presented the previous year to the American Society of Civil Engineers. I have kept in touch, of course, with this matter since. It is one in which I am largely interested. I think possibly I can give you some supplemental data to that in the report of the Committee. I notice the report speaks of preservatives to be used as a paint or both; table 1. It is, of course, unwise to speak unfavorably of anything of which we have no evidence. I have no confidence in the ultimate success of any treatment which is in the nature of an outside application. You can't make a tie of much consequence by painting it over and soaking, unless, indeed, you take the method followed in Massachusetts and soak it for a week. The report speaks of the experience of the Santa Fe road, and gives the results which they have attained. During the past year, I understand, they have been making some rather extended investigations into the result of their past year's work, and those investigations have been quite satisfactory so far as evidencing the value of the treatment. I understand there has been some doubt in their mind as to the comparative value of the burnettizing and the Wellhouse process. You probably know that in burnettizing you simply inject the chloride of zinc alone. In the Wellhouse process you inject the chloride of zinc and also a solution of glue and tannin. The solution of glue and tannin may be put in in separate injections, and the treatment is then designated as the three-process. The glue and the zinc may be injected in one solution, followed by the tannin by itself, and it is then called the two-process. The investigation which Mr. Chanute made some years ago satisfied him that the three-process was very much superior to the two, and he recommended to those companies which were using the Wellhouse treatment that they should make the change from the two to the three process. None of the companies did this, however, and the only place, so far as I know, where the three-process has been practiced has been in Mr. Chanute's works. The reason for the injection of the glue and of the tannin is that the glue and the tannin in conjunction are supposed to form particles of artificial leather, which plug up the pores of the timber and prevent the subsequent leaching out of the chloride of zinc. This they do to some extent, but when you inject the chloride of zinc and the glue in one solution you are first steaming the tie and putting it under vacuum for the

purpose of withdrawing the sap and the moisture which it contains, and then you are filling it again with an injection of organic matter—the glue—just what you have been trying to eliminate. Part of the glue is probably neutralized by the zinc, but that means that you are throwing the zinc away. Then another difficulty is this—that is established beyond any question, I think—that it is impossible to get the same degree of penetration with the chloride of zinc and the glue in the same solution that you can if you inject the chloride of zinc in a solution by itself. Chemical tests of which I have seen analysis, showing the amount of chloride of zinc remaining in the center of the tie after treatment, are quite conclusive that there is very much less chloride which reaches the center of the tie with the two-process treatment than reaches it with the burnettizing or with the three-process. About ten years ago the Santa Fe railroad departed from the Wellhouse process and went back to the old burnettizing method, simply injecting chloride of zinc. This was followed for two years, and then they began again to use the Wellhouse process. There is, of course, some additional cost—I believe it is estimated at four cents a tie—which attaches to the use of the glue and the tannin, both in the cost of materials and the increased time of operation necessary; and the officials of the road have not been satisfied that that increased cost resulted in corresponding benefit. During the past year they have made an extended investigation, trying to determine the question, and the conclusion they have reached, I believe, is that they will in future burnettize all their ties, not using the glue and the tannin. Their conclusion may be correct, but the facts upon which they base it, as given in their reports, do not demonstrate this. It is, of course, another instance of the difficulty of going to work after a series of years and endeavoring to establish facts on such a large scale. It may be that the change they have made is one which will prove profitable. I think for a great portion of their road they possibly will get just as satisfactory results from the burnettizing as they do from the other, because a very large part of their line is in an extremely dry climate. I understand that beginning with the first of last year they have been using treated ties on the entire system. Prior to last year they were only used on the western and New Mexico divisions.

The Rock Island road is referred to here, and I may say with reference to that road that when I wrote my paper on this subject three years ago there was considerable doubt in the minds of some as to the results obtained on that road. The figures obtained since then have, I think, been much more carefully kept than in past years, and demonstrate, to my mind, that the previous records were substantially correct. A lot of ties were laid in a section of this road just west of the Missouri River. This consisted of 22,000 treated hemlocks and 50,000 white oak untreated. Those ties were laid in 1886. The result at the end of 12 years showed there were 63 per cent of treated hemlocks which had been removed after 12 years, and 74 per cent of the white oaks had been removed. I have just received a statement of the count made at the end of 1900, which showed that of the 22,000 treated hemlocks put in in 1886 there are 2,600 still in the track, and of the 50,000 white oaks there were 2,400 still in the track, so that while there were less than half the number of hemlocks, there were more hemlocks in the track today than there were oaks.

The data of the Southern Pacific, as given in the report is, of course, correct, emanating as it does from both Mr. Chanute and Mr. Kruttschnitt, but I notice that it is not brought down to date. It speaks in the report of the removal of ties on the Glidden and Del Rio divisions. One of the questions that has been frequently asked me in correspondence has been this: What is the evidence of the results of treatment where ties are subjected to such rainfall as we have in the eastern part of this country, for instance? The Glidden division of the Southern Pacific runs from Houston to Glidden. The rainfall at Houston is 49 inches. From government reports I gather the average for the division would be about 40 inches, which is about as heavy as we have in any part of this country. Now, on this Glidden division I don't think the number of ties laid was very large—how large I have no information. However, the number was sufficiently large to give results of some value, because my recollection is that in the last six or eight years they have removed about 10,000 from that division. The statement is given in the report that when treated the ties have lasted from six years and eleven months on the Glidden division, where the rainfall is heavy, to nine years and two months on the Del Rio division. The latest report, which brings the Southern

Pacific data up to this year, is that the average life of the ties so far removed on the Glidden division is seven years and six months, and for 1899 the average life of the ties removed that year was eight years and six months. When you consider the life of the ties that have been removed, you are not necessarily getting the life that you derive from the average ties, because you have got to take into consideration whether you have reached the maximum life of the ties. For instance, if you put in a lot of ties in 1890, the average life of the ties you removed last year or that you have removed to date is no criterion of the life of the ties you are going to get, because there may be a lot of those 1890 ties—possibly 50 per cent of them—still in the track. The consequence is—I call your attention to the fact—that on the Gidden division the average life has been increasing year by year. Each year there is an increase, so we don't know what the average is going to be for that division.

The division next to the Glidden is the San Antonio division, running from Glidden to San Antonio. The rainfall there is 30 to 40 inches, and my recollection is that the average life there is something like nine years so far; that is, the life of the ties taken out. The average life of the whole lot is given in this report as eight years and three months. The last report shows eight years and ten months, and that is only for these three divisions. It is not for the entire system of the road. On July 1, 1900, of the ties which were laid in 1889, 63 per cent were still in the track; of the 1890 ties, 64 per cent were still in the track, and of the 1891, 78 per cent. I could give you the percentages for the following years, but the above is sufficient to indicate the point I want to make, that the life of the ties removed is not necessarily the life you may expect from the average ties.

There have been ties laid in other places which may possibly be of some interest to you. On the Pittsburg, Fort Wayne & Chicago road, in June, 1892, there were 200 tamaracks and 200 white oaks laid in adjoining sections. Up to 1899 only two of each of these had been removed. In 1900, 71 of the 200 tamaracks and 27 of the 200 white oaks had come out. Now, it is not wise to jump at the conclusion that the white oaks give the longer life, because you will have to wait a few years longer.

Those ties were laid in gravel ballast. In the same month 200 untreated white oak and 200 treated hemlocks were laid on that road. There was one treated hemlock came out in 1897, four in 1898, six in 1899. There were eight white oaks that came out in 1899. None of either came out last year, so that in both cases there have been practically 5 per cent of those ties removed after eight years' service. These were in stone ballast. Whether the longer life of the hemlocks is due to being laid in stone ballast or due to the superior virtue of the treated hemlock, as compared with the treated tamarack, is a conundrum I cannot answer. I notice in the report there is a reference to a test with ties creosoted only to a small degree, with so far good results. One of the systems of treatment that will probably come to the front in the next few years is the combined zinc and creosote. As you are aware, the Germans have been treating by such a method for some years, with quite satisfactory results. There is one difficulty with it, however, and that is that the zinc and the creosote, according to the German method, is injected in one solution. In order to make this possible, it is necessary to use a creosote which is exceedingly light in its specific gravity. The percentage of tar acids is extremely high; in fact, so high that I do not think any creosote works in this country would use it. It is a high-priced creosote, but seems to answer their purpose. In this country there have been a number of attempts made to get good results by chloride of zinc and creosote combined, and of late this has been attempted in the South by the method of injecting first chloride of zinc and following it by injections of creosote, using such creosote as would be used for ordinary creosote work. This has resulted in success, so far as securing the injection of the creosote is concerned.

I want to call your attention to one element in this matter. We are now, and will be more in the future, invited to use all kinds of patented and peculiar preservations. In discussing my paper recently, I remarked that it is almost necessary to say to an inventor who brought some good scheme, on paper, for timber treatment, "Just kindly take that away and put it in the storehouse for fifteen years and then come back and tell us about it," because experience has demonstrated in this country beyond any doubt that laboratory tests of timber preservation are a farce.

Twenty years ago there were several methods which gave every promise of good results. They were methods which depended upon chemical reactions taking place in the timber. Of anything of that kind I have very serious doubts. These reactions, apparently, took place in the timber. The chemist found the results, but when you put the tie in track, you did not find the results, or at least they dug the results out after a few years. If we can find some means by which zinc chloride and creosote can be used in conjunction, there will be no experiment about it. We know zinc chloride is good; we know the creosote is good, and it is simply a question in my judgment as to the practicability of injecting the two materials in conjunction, and the cost of the treatment.

I notice no member comments on the question of keeping records and of piling the ties and examining the ties after they have been removed. Mr. J. B. Berry, Chief Engineer of the Union Pacific, some years ago said to me that in his judgment the most essential thing in the tie business was what he called the post-mortems. He was in the habit of having the ties removed each year piled up. He did not leave it to the section foreman, roadmaster or anyone else, as to whether they were good, bad or indifferent. They took them out in their judgment, but he examined them himself afterward, before they were destroyed; and that is what he called his post-mortem. I have been told recently that one railroad that has been using treated ties has begun to realize it is a large proposition, and worth careful consideration, and among some of the officials the question is being considered of having one man whose business it shall be to simply and solely chase after the ties and watch the tie record. That gentleman will have my sympathy.

Dr. Von Schrenk:—I will say a few words with reference to the specimens. This is a piece of a white oak tie from Maryland, to show the natural life of the tie in that locality. This piece shows one of the spores growing on the outside of it. This is a tie that has been in one of our culture chambers for about two months, to show how the tie may look very sound to the roadmaster, but is really partially decayed; you will see the evidence of that yourself by looking at it to see how the fungus has grown out all over the surface. When we first received that tie

it looked as plain as this one here, only the wood looked absolutely sound. This other piece is to show the way in which the natural decay may take place in a year and a half in the Southern States—in the pines. This is from a pile of timber stacked six feet above the ground, so that it was right up in the air, and it shows the amount of decay which had taken place; here on the end you see the fruiting bodies. To be sure there may be no mistake, and to show this fungus may do exactly the same thing in ties, I pulled out two samples of the pine ties that had been in the track two years and a half. These three ties are very good samples of how treated ties, after being in the track three years, begin to decay. On the label I have left out the kind of treatment given these ties, so as not to cause too much embarrassment.

Vice-President Peterson:—You say there is no use putting on any kind of material on the outside—that timber begins to decay in the heart? What causes the decay in the heart when it is all covered with some sort of material to keep the germs out—either paint or something of that kind? When the timber is painted very closely, will it begin to decay on the inside?

Dr. Von Schrenk:—That is due to the fact that before the timber has been painted these germs of decay had already gotten into the wood, and when you paint the wood you bring about the best condition for cultivating these fungi by making a moist chamber; you very carefully preserve all the moisture that may be in it for the benefit of the fungus that is already inside the timber. The timber may be recently sawed, but a great many of these fungi get in through small defects which every piece of timber has. You must remember that these spores are so infinitesimally small that you cannot find a piece of wood sawed in the forest anywhere in the regions where these fungi are growing that is not likely to be affected. I will be willing to hazard the statement that any board that is cut and brought into the city from the forest is already covered with these fungi. The best proof of that you find in the characteristic defect which the timberman calls "bluing."

A vote of thanks was then extended to Dr. Von Schrenk for his very interesting address.

Mr. C. E. Wickham (Chicago, Rock Island & Pacific):—We have had a little experience with treated ties and we find that

a good deal depends on the ballast that the ties are put into. For instance, on our lines east of the Missouri River—all of them comparatively well-ballasted lines—the treated ties do not last as well as the untreated ties. We have some on the Illinois division that were put in in 1895, which we marked; that is, we marked all the burnettized ties we put in that year with a nail in the top of the tie, and I noticed this last fall that these ties as a general thing are beginning to show signs of decay. Our experience has been also that whenever a burnettized tie begins to decay it goes very quickly. For instance, a tie shows signs of decay in the fall. The roadmaster may think it will run another year, but he will find in the spring, in nine cases out of ten, that he is mistaken, and that the tie is ready to come out. The decay in these ties is all of the same nature. It seems to be a sucking-out of the preserving fluid by the ballast, leaving a sort of cellular structure in the tie, and this shatters under the weight of the rail.

Mr. F. H. McGuigan (Grand Trunk):—I understood the gentleman to say that untreated hemlock ties last longer than the treated ties—of the same wood.

Mr. Wickham:—Not of the same wood. One is a cedar—the untreated tie is a cedar, and the treated ties were hemlock.

Mr. McGuigan:—But an untreated cedar tie ought to last twelve or fourteen years where it is not worn out, while a hemlock will last from three to seven years only, according to the character of the ballast and the land from which it is cut. We use a great many cedar ties on the Grand Trunk, and while I have not been with the road long enough to know positively, I am told their average life is better than twelve years.

Mr. Wickham:—Our experience has been that with the traffic we have the average life of a cedar tie is hardly as long as you say—about eight years—the cedar tie is then ready to come out.

Mr. McGuigan:—That, of course, depends upon the amount of traffic that passes over them and the weight of the rail used.

Mr. Wickham:—We have a few untreated hemlock ties in the track and we cannot see any difference in the treated and the untreated ties on this ballasted track. In dirt ballast, where there is more or less moisture, they last much longer than they do in a well-ballasted track.

Mr. E. B. Cushing (Houston, East & West Texas) :—The experience of one of the gentlemen as to treated and untreated ties in ballasted and unballasted track is diametrically opposed to the experience of the Southern Pacific, who have had a number of years' experience in this matter. In other words, they don't advise the use of treated ties in unballasted track, but ties are said to last very well in ballasted track. But they seem to draw the line of advantage between treated and untreated ties entirely by the condition of soil and climate. For instance, in the eastern division of their road they use cypress altogether. They use no burnettized ties on the Gulf prairies. West of San Antonio they use altogether in that arid country burnettized ties, and it does not seem to be with them a question of ballast, but one rather of soil and climate and conditions of humidity, rainfall, etc. Now, I notice in this report of the Committee they refer to a little report that was gotten up by the Texas Association of Superintendents of Railways, in which we found that in that locality the life of ties varies very materially. For instance, some roads get a life of fifteen years for cypress, whilst other roads have a life of five years for oak in the same country. This little study that we made of the tie subject also convinced us of the necessity for systematic records. In our little Association there are some nine or ten thousand miles of railroad represented, and I think there are some twenty lines that make that mileage. We found that we were unable to get satisfactory reports of over four or five lines. They could tell us how many ties were used in a year, but in the progressive state of western railroads where they are building sidetracks, etc., very few roads could tell us how many of those ties were used in construction, as against maintenance repair, and as you see in this statement, it shows that on some roads the renewals were about 200 per year, and on other roads in the same territory renewals were about 550, so it led us to the conclusion that it was first a question of timber and second of soil. The International Railroad which traverses the state uses on one part of its road cypress ties, on another part oak, and another part pine. We have seen that this question should be considered not only as a question of the differences in timber, but largely of the soil and climatic conditions.

On page 7 of the Committee's report, reference is made to the results of a trial of ties which had been treated with a little less than two gallons of creosote per tie, showing that after five years there had been removed some 16 per cent of untreated ties and not one of the treated ties, although the ties treated were the same kind of timber as those which showed such a percentage of decay. There seems to have been very little experimenting done with light treatments of creosote, although there is reason to believe that such experiments would show good results. If we are to treat ties for low, moist sections of the country, some more lasting substance than a mineral salt such as is used in burnettizing and similar processes should be found. The combined treatment that Mr. Curtis spoke of may do, but it is expensive. I had a few hundred of ties treated by this process. First, the sap was extracted in the cylinders by vacuum pumps, then the solution of zinc chloride was injected. The solution was then run off and the oil pumps started. The absorption of oil, as I recollect it, was a little less than one-half gallon to the tie. The ties, when removed, looked as if they had been creosoted. I don't know what the cost of this was to the contractor, but the treatment alone cost us some thirty cents per tie. You will note that the light creosote treatment referred to cost the Southern Pacific about nineteen cents per tie.

The question of systematic record and comparative trials of the different kinds of ties in the same locality is an important one. If I am not mistaken, the place where the experiment referred to on page 7 was made, was on a division of the main line near Watkins, Texas. If so, I was connected with the work and our efforts on the line of comparative trials may interest some of you.

The new line was about two miles long, the east end being built around a rocky point, and the west end across a vega or sandy plain. We obtained a number of each kind of the ties used in that territory, and laid a portion of each of these at either end of the line, subdividing them so that a portion of each should be laid on curve and a portion on tangent. We used heart pine, sap pine, burnettized pine, creosoted pine, sawn cypress and hewn cypress. I think we also laid part of the ties without tie-plates and part with them. Thus each kind of tie will have a trial in

rock ballast and in earth, on curve and on tangent, with tie-plates and without. Mr. Kruttschnitt, their General Manager, takes great personal interest in these matters, and in the course of time will no doubt have further interesting data to give us, showing the annual replacements of each kind of tie and under the several conditions. The Cross Tie Committee of the Texas Association of Superintendents will recommend to the lines represented the plan of trial miles of track on each road where the various kinds of ties may be laid, each kind together, and preferably an even hundred of each kind, so that percentages of replacements may be accurately and easily obtained each year.

One other matter I think well to bear in mind. It may be said that the subject of tie preservation is in its infancy in this country. It is a process that combines chemistry and mechanics, and the literature on the subject, though recently added to, is not very extensive. Each person who undertook to do the work had to study out the matter for himself. It is not to be wondered at that some mistakes were made. I know of one superintendent who for some time pumped from his solution tanks with no sort of "agitator" to keep the zinc salts evenly dissolved. It is probable that some of the ties received a water treatment, whilst others got more than their share of the chloride. If those water-treated ties were laid together, as they probably were, some foreman no doubt had an adverse report to make on burnettizing. In another instance the treating was done for quite a while under too great a heat, and the fibers of the wood were "shortened" and the ties were brittle, "shivering" under traffic. The wood-preserving works should be under direct charge of a man who is competent to judge of these matters.

There is little doubt that the ties treated in later years will show much better results than the earlier treatments.

Mr. D. W. Lum (Southern Railway):—We find a great difference in the life of ties in our country, depending very largely upon the character of the timber. I know of a great many heart pine ties, that is, strictly heart pine, what is called in the South light wood pine, that are sixteen to eighteen years old. I know them to be sixteen years old from my own observation. There are a great many cedar ties that last from sixteen to eighteen years where the traffic is not heavy, that is, not heavy enough to

cause the rail to cut into the tie, and we have several kinds of cypress. A heart cypress is very durable, while the sap cypress will last only a very short time, so that I think that in gauging the life of ties we should consider the quality of timber.

Mr. E. F. Wendt (Pittsburg & Lake Erie):—Under the heading of "Cost" on page 8, I suggest to the Committee that it would be well to add a column in which would be stated the character of the ballast used by the different railroads. The record shows that 68 per cent of the railroads reporting found that the average cost of tie removals per tie was 10 cents, while 20 per cent find the average cost was 15 cents. One road reports as low as 1½ cents per tie, which would indicate that the cost on the Philadelphia & Reading and the Pennsylvania lines was 10 times as great as on the D. & R. G. It seems to me that the roads reporting have not all included the same amount of work, and there should be uniformity in the base of the report. It seems to me also that the difference in cost between those reporting 10 cents and those reporting 15 cents has been due primarily to the character of the ballast. If I am not mistaken, those reporting 10 cents generally have gravel ballast and those reporting 15 cents generally have stone ballast. In addition to this I feel quite confident that roads using slag ballast would report a slightly higher cost per tie for renewals than those using stone, so it is quite evident that the character of the ballast has much to do with the cost per tie. On page 10 I notice that the Committee refers to the value of standard specifications, and I hope that next year the Committee will submit a set of standard specifications for our information—specifications which will govern the purchasing agent in his purchase of ties.

Mr. Curtis:—Before we get away from this subject I wish to say that I made the statement that I had never been able to find any evidence with regard to the use of any preservatives mentioned in table 1 of this paper. It seems we have a representative of one of the preservatives here, and the gentleman hunted me out to show me some papers evidencing the merits of his preservative. I was careful to say I had not found the evidence. The gentleman has some letters which speak remark-

ably well of his preparation, and in justice to him I will call attention to this fact.

Vice-President Peterson:—It is now 5:30 o'clock and I do not think we shall have time to take up the question of tie-plates to-night. We will therefore adjourn to meet at 9:30 to-morrow morning.

WEDNESDAY, MARCH 13, 1901.

President Wallace:—The first order of business this morning is the report of the Committee on Bridges and Trestles. The Secretary will read the names of the members composing the Committee, and the Committee will please some forward.

REPORT OF GENERAL COMMITTEE No. VII, BRIDGES AND TRESTLES.

To the Officers and Members of the American Railway Engineering and Maintenance-of-Way Association:

Your Committee No. VII. on Bridges and Trestles, beg leave to report as follows:

We commenced our labors after the close of the first annual convention under the able leadership of Mr. Onward Bates, Engineer and Superintendent of Bridges and Buildings of the Chicago, Milwaukee & St. Paul Railway, as Chairman of our Committee. After careful consideration of the magnitude and importance of the subject assigned to us, we decided to divide our work and place certain specific subdivisions of the work in the hands of sub-committees, believing that the concentration of thought by these sub-committees on separate subjects would produce the best results for the Association. How far we have succeeded in this idea, the convention can judge for themselves.

The different Sub-Committees and subjects are as follows:

7-A. Mr. I. O. Walker and Mr. D. W. Lum:
Timber bridges and trestles, including design, materials, cost, durability, and the conditions which warrant the use of timber in preference to metal construction.

7-B. Mr. B. Douglas and Mr. R. Modjeski:
Metal bridges and trestles, including design, types, limiting spans and erection.

7-C. Mr. Aug. Ziesing:
Metal bridges and trestles, maintenance and limit of service of old or light structures, with plans for strengthening the same.

7-D. Mr. Theo. L. Condron and Mr. Wm. Michel:
Metal bridges and trestles, specifications, quality of materials, method of manufacture, mill and shop inspection.

7-E. Mr. W. A. McGonagle and Mr. J. P. Snow:
Docks and wharves, design, maintenance and operation.

7-F. Mr. Edward Barrington:
The Mexican practice in railway bridges.

It was the opinion of the General Committee that the Sub-Committee reports should stand separately in the annual report of the General Committee, in order that each of the Sub-Committees shall receive full credit for their work and thus permitting a minority report to be made in such cases where the Sub-Committee are not of unanimous opinion.

It is the opinion of your Committee that a great deal can be done towards systematizing and even standardizing railway bridge practice without in any way interfering with the individual practice of any member of the Association.

Your Committee has been very unfortunate in being deprived, through serious illness, of the master mind and master hand of its original Chairman, Mr. Onward Bates, in pursuing the investigations and shaping the report of the General Committee. So serious was the illness of Mr. Bates, that in November last he felt compelled to tender his resignation as Chairman of the General Committee, and the Vice-Chairman, Mr. W. A. McGonagle, at the urgent solicitation of the Board of Direction, consented to serve as Chairman. It is the hope of all the members of our Committee that Mr. Bates will very soon be fully restored to health and strength, and that he will again take up the work of our Committee, for which he is so thoroughly fitted by knowledge and experience.

Your Committee has been handicapped by the general prosperity of the country, which has required every railroad official to devote nearly every moment of his time to the service of his employers, leaving but little time for the necessary work of collecting and arranging data for committee reports, and while we do not desire a return to the *strenuous* times of five years ago, yet we do desire that a proper amount of time should be required by the railroad companies of such of their officials as are qualified to do so, to collect, compile and impart to properly organized railroad associations such data as will be of mutual benefit to all the railroad companies represented in the Association.

The various reports of the Sub-Committees follow in the order outlined above. It has been impossible to get satisfactory replies to the list of questions asked in all cases, and in some cases no replies have been received at all. The reports have therefore, in some cases, been given in outline, thus permitting additions to be made from year to year, as fast and as complete as the needed information can be secured.

The thanks of the General and Sub-Committees are due, and are hereby tendered, to Mr. L. C. Fritch, Secretary of the Association, for very

valuable assistance rendered in collecting and compiling the facts upon which our report is based.

Very respectfully submitted,

W. A. McGONAGLE, Duluth & Iron Range Railroad, *Chairman;*
ONWARD BATES, Chicago, Milwaukee & St. Paul Railway;
A. ZIESING, Consulting Engineer, Chicago;
I. O. WALKER, Nashville, Chattanooga & St. Louis;
E. BARRINGTON, Consulting Engineer;
R. MODJESKI, Consulting Engineer, Chicago;
D. W. LUM, Southern Railway:
B. DOUGLAS, Michigan Central Railroad, Detroit, Mich.;
WILLIAM MICHEL, Hocking Valley Railroad;
T. L. CONDRON, Civil Engineer, Chicago;

Committee.

REPORT OF SUB-COMMITTEE ON PILE AND FRAME TRESTLES.

D. W. LUM, Southern Railway, Washington, D. C.;
I. O. WALKER, Nashville, Chattanooga & St. Louis Railway, Paducah, Ky.;

Sub-Committee.

In placing this report before the Association, the Committee would point out that only about one-fourth of the mileage of the United States has been reported on. They have not deemed it expedient to base any recommendations on the amount of data at hand. The report is, therefore, rather a statement of data collected for the information of the Association than an attempt to outline standard dimensions or practice.

The Committee regrets to state that they have been unable to secure sufficient cost data to warrant them in reporting either on yearly cost of maintenance or renewals.

It is hoped that, with the coöperation of our bridge departments, the Committee can submit some useful data at the next meeting.

It will be impossible to discuss intelligently the subject of economical treatment of trestle filling unless complete cost statements are at hand.

IRON COVERING.—Iron covering for stringers or for stringers and caps is used on six railroads, having a total mileage of 9,791. Of these the Cincinnati, New Orleans & Texas Pacific Railway has used iron covering the longest. They use No. 15 galvanized. What was put on twenty-four years ago is still good except a small percentage that has failed by crawling and breaking at bend over corners of stringers.

The Nashville, Chattanooga & St. Louis Railway has used No. 22 galvanized iron for fourteen years. It is still good.

The Toledo, Peoria & Western Railway, using No. 22 galvanized iron, has had it cut out in six years by acid from green white oak ties.

ORGANIZATION.—The Committee has secured considerable information regarding the organization of the bridge departments on various roads, but decided this matter should properly be handled by Committee No. XII.

AVERAGE YEARLY COST OF MAINTENANCE.—No accurate information has been secured. The estimates run from 5 to 70 cents per lineal foot per year. The Committee expects to have more definite reports at the next meeting.

The Committee suggests that records be kept of cost of maintenance separate from renewals.

TIMBER PRESERVATION.—Eight roads, with mileage of 17,125, use some sort of timber preservative, divided as follows:

Woodiline on	336 miles
Letteny	2,221 miles
Creosote	10,854 miles
Carbolineum Avenarius	3,714 miles

The Carbolineum Avenarius has not been in use long enough to report definite results. The Creosote alone seems to have been used long enough to give complete data. All report excellent results where creosote has been used, the claim being made that it triples the life of timber treated.

The cost per thousand feet B. M. for treating with preservatives is not reported on, as definite data has not been received. The Committee requests that members keep an account of this expense, so that it can be reported on at the next meeting.

NUMBERING BRIDGES AND TRESTLES.—The mileage reported is as follows:

Consecutively	15,682 miles
Mile and telegraph pole	183 miles
Mile and letters	8,940 miles
Mile and decimal so as to show distance from terminal	16,427 miles

The Plant System uses the mile followed by the number of the bridge in the mile.

TIE-PLATES.—Eighteen roads, with 37,000 miles, use tie-plates to greater or less extent. About one-half the roads are making tests. Wherever tie-plates have been used for some time, good results are reported, especially on curves, and at points where sand is used by the engines.

PILE-DRIVER.—The average weight of hammer used is about 3,000 pounds, and the average height of leads about 36 feet. The Committee will ask for driver plans at some future date and proposes to design a driver which will embody the best practice.

ELEVATION OF CURVES.—Super-elevation on curves is secured as follows, and mileage of roads using the different methods is shown:

By framing elevation in posts or piles	31,553 miles
Sizing ties or by taper ties	3,795 miles
By size of corbels or some method of blocking	12,639 miles
Not reporting	2,230 miles

Nutlocks.—The slotted washer with nail driven against the side of the nut and side of the bolt head has come into very general use.

A few roads use some form of patent nutlock, and a few nick the thread with cold chisel after nuts are tightened. The slotted washer costs, practically, nothing extra; its use does not damage the bolt or nut, it is not patented and it is effective.

One large system uses a washer with one-fourth inch by three-eighths inch hole cast in washer at proper place for nail.

End of Bank Finish.—The timber wall or bulkhead is most generally used, only one road reporting a standard masonry bulkhead. The thickness of timber varies from two inches to eight inches and the depth varies from two feet to six feet.

Corbels or Bolsters.—Of the roads reporting, seven, with a mileage of 12,051, use corbels and favor them, saying that stringer has larger and better bearing, has greater stiffness and longer life. Some report that corbels add two years to life of stringers.

Pile Protection.—The Committee has not as much information on this subject as they desire, and simply report information at hand.

The only method of treating reported on is creosoting. Excellent results are reported. One system reports using creosoted piling in salt water, surrounding same with terra-cotta pipe, filled with concrete, as protection against the teredo. One engineer reports prolonging the life of piles some five years by piling earth against them and gradually raising the ground line.

One road reports creosoted piles driven in salt water sixteen years ago, and inspection last year by divers showed all sound, except 33, which had been injured by teredo; it is thought this was due to defective creosoting.

Inspection.—The average of reports would indicate inspections made about as follows:

Monthly by bridge men;

Once or twice a year by Bridge Engineer, Engineer of Maintenance-of-Way, or Chief Engineer;

Three roads report this work done by regular bridge inspector.

One road requires the Bridge Supervisor or Bridge Engineer to ride the engine of a fast passenger train over the bridges once each way each month. The results are excellent. The slightest defect in line or surface of trestles or track near them is promptly detected. Weak stringers will become apparent. Any unusual oscillation noted is made the subject of prompt personal examination by the Supervisor.

Ballasted Trestles.—Of the roads reporting, three, with a mileage of 14,931, use ballasted trestles to a greater or less extent. Two of these use creosoted piles and timber throughout, and one does not use treated timber or piles. The depth of ballast varies from four inches to ten inches. The distance between side timbers varies from ten feet to fourteen feet.

One road reports cost of ballasted trestles to vary from $6.50 to $8.00 per lineal foot. Timber untreated.

Through the courtesy of the Chief Engineer of the Atchison, Topeka & Santa Fe, the Committee presents the following table of cost for ballasted trestles. All piles and timber creosoted, five piles to bent; floor fifteen feet wide; floor timber, 12x12 and 10x12; span, 14 feet; depth of ballast, 10 inches; caps, 12 inches by 12 inches by 16 feet.

COST PER LINEAL FOOT OF CREOSOTED, BALLASTED TRESTLES, BUILT FEBRUARY, 1899, A., T. & S. F. RY., CHICAGO DIVISION.

ITEMS.	No. 535. Length 280 ft. Height 20 ft. Piles Av. 35 ft.	No. 536. Length 996 ft. Height 19 ft. Piles Av. 30 ft. 4 in.	Average of These Two Trestles. Piles Av. Length 32 ft. 8 in.
Cost of Piles (Treated)	$5.47	$4.58	$5.02
Lumber "	5.01	5.02	5.01
Bolts	.22	.20	.21
Cross-Ties	.24	.24	.24
Ballast	.30	.27	.28½
Labor (All Kinds)	2.14	1.64	1.89
Creosote	.01	.00	.00½
Total per Lineal Foot	13.39	11.95	12.66

FRAMED TRESTLES.—Nearly every road uses framed trestles, varying in height from 3 feet to 110 feet. The span varies from 12 to 20 feet. The distance between decks where trestle has more than one story varies from 24 to 30 feet. The average life of framed trestles is ten to twelve years. The timber most used is Southern long-leaf yellow pine, although many roads use Oregon fir.

Three styles of foundation are in use—piling, small masonry piers, and timber mudsills, or, in some cases, timber cribs.

PILE TRESTLES.—On this subject the Committee only reports progress and outlines the information at hand.

PILING.—The various kinds of timber used, and the reported average life are noted below. Timber not treated.

White oak	11 years
Spruce	9 years
Oregon Pine	7 years
Chestnut	15 years
Tamarack	11 years
Yellow Pine	9 years
Redwood	15 years
Red Cedar	22 years
Cypress	7 years
Fir	10 years
White Pine	8 years

Creosoted piles are used by five roads, with a mileage of 15,979. The increased life due to treatment is reported at from 200 to 400 per cent. Only a few roads report hewing piles before driving.

STRINGERS.—Of twenty-seven roads reporting, twenty use yellow pine for stringers, six use Oregon or Douglas fir. A number of roads use white oak, white pine, cypress, etc., but yellow pine is generally used and in double lengths. The heaviest stringer reported is used by the Terre Haute & Indianapolis Railway—three pieces, eight inches by twenty inches by sixteen feet under each rail and eight inches by twelve inches by four foot corbels. The average length of span is fourteen feet four inches. In general, three stringers to the rail are used where span is fourteen feet or more, and two to the rail where span is less than fourteen feet. Double-length stringers are almost invariably packed with cast-iron washers or separators. Single-length stringers where no corbels are used have a packing block about four feet long packed between them and notched over caps.

The cast separators used vary from seven-eighths inch to four and one-half inches.

TIES.—The timber used for ties is almost equally white oak and yellow pine.

Ties are almost invariably eight inches wide and vary in depth from six inches to ten inches, and length from nine to fourteen feet.

The clear distance between ties varies from four inches to ten inches. More than half the roads reporting show clear distance less than six inches.

Two large roads use five-inch iron dowels to fasten ties to stringers, in addition to the usual guardrail.

GUARDRAIL.—Every kind of timber used in bridge construction is used for guardrails, about one-half the roads using clear yellow pine, usually all heart. Size is very variable. The smallest is 5x6 inches and largest 8x10 inches. Some roads face the guardrail with iron, and one eastern state has passed a law requiring this to be done.

CAPS.—The practice as to caps is so uniform that there is little room for comment. Some roads are using a cap built up of smaller pièces, some use two pieces on edge with tenon on post or pile between them; others add a top piece which lies flat on the other two. The Committee is investigating this cap and will have report at future date.

FASTENING THE DECK TOGETHER.—No two roads have the same method. The majority of the roads fasten the ties to the stringers by dowels, drift bolts or spikes, and the ties to guardrails by bolts, and stringers to caps by drift bolts, or by notching stringers over caps. In some cases a bolt passes through guardrail tie, jack stringer and cap. Ties are invariably kept in place by dapping the guardrail down on them from 1 to 2 inches. The lateral motion is prevented by iron or wooden blocks or drift bolts. The subject of bracing is postponed to a future report.

NOTES.—Some notes of general interest have been gleaned from submitted reports and drawings:

One road has abandoned the use of broken joints in double-length stringers, on account of cost of repairs.

One road had trouble from piles sinking in a soil mixed with stone. The trouble was overcome by using frame bents on mudsills.

One road uses sound selected red cedar for all posts in frame trestles.

Several roads carry the wooden or outside guardrail out on the embankment and throw it out to guide derailed equipment back towards the track.

Most of the drawings submitted seem larger than necessary. Some plans were 3 feet wide and 7 feet long. For field use and constant reference a plan 12x20 inches can carry all the information needed. One road uses a book made up of standard plans, each page about 5x11 inches. This makes a handy reference book.

A number of roads are buying their timber already sized, and report great saving in expense of framing and much more uniform work.

One road reports ties surfaced on one edge at $1.00 per thousand extra.

Several roads report using cabooses for lodging and boarding the bridge gangs, and with excellent results.

REPORT OF SUB-COMMITTEE "D"—SPECIFICATIONS.

THEO. L. CONDRON AND WM. MICHEL.

There is scarcely a field in which greater good can be wrought by this Association than in the harmonizing of the many varying specifications for structural steel for bridges and other structures, now in use by the railroad companies of the country.

As a basis for discussion and criticism, the standard specifications for structural steel, proposed by the American Committee of the International Association for Testing Materials, are here presented, with certain modifications suggested by your Committee. These modifications are clearly indicated in the text, and the paragraphs in the quoted specifications, which are not recommended by your Committee, are printed in small type and marked "omit."

In explanation of the accompanying diagram, Fig. 1, it should be stated, that when the Committee of the International Association for Testing Materials issued their proposed specifications, they accompanied them with an extensive table showing the requirements of 39 existing specifications. As the mass of figures in this lengthy table was confusing rather than convincing, the diagram here presented was prepared by a member of this Committee to show graphically the lack of uniformity, to say the least, between all of these specifications. The recommendations of the Committee of the International Association are shown by bands of hatching across the plate, while those of your Committee are clearly indicated by solid blocks of black on this diagram. These latter conform to the most general requirements of existing specifications.

It will be appreciated that where comparatively small quantities of steel are ordered, under other than commonly accepted standard specifications, it is hardly to be expected that steel differing from the ordinary product of the mills will be obtained. But when any specification becomes a standard generally adopted by many large buyers, the manufacturers vie with each other to bring their products up to the full requirements of such specifications.

By taking advantage of the systems of tracing material now necessarily adopted in our larger mills and making it the duty of inspectors to check upon these records, then the reports of the tests called for will become bona fide records of the quality of the material furnished and the entire work will be made harmonious with the workings of our mills, to the great benefit of all concerned. There is both reason and precedent for each of the recommendations here offered, but it would make this report too lengthy to go into details regarding the same at this time. We therefore simply present these modified specifications for your consideration and criticism:

PROPOSED UNIFORM SPECIFICATIONS FOR ROLLED STRUCTURAL STEEL.

ocess of anufacture.

1. Steel shall be made by the open-hearth process.

Recommended.

emical operties

2. Each of the three classes of structural steel for bridges and other structures shall conform to the following limits in chemical composition:

*Phosphorus shall not exceed 0.08 per cent. in steel made by the acid process; nor 0.06 in steel made by the basic process.

*Sulphur shall not exceed 0.06 per cent. in steel made by either the acid or basic process.

*Omit.

Substitute for the above the following:

2a. The percentages of phosphorus and sulphur in rivet steel shall not exceed 0.03 of one per cent. The percentage of phosphorus in grades of steel other than rivet shall not exceed 0.04 of one per cent. for basic, nor 0.06 of one per cent. for acid steel.

2b. The percentage of sulphur in grades of steel other than rivet shall not exceed 0.05 of one per cent. for either acid or basic steel.

ysical operties.

3. There shall be three classes of structural steel for bridges and other structures, namely, Rivet Steel, Soft Steel and Medium Steel, which shall conform to the following physical qualities:

nsile Tests.

4.	Rivet Steel.	Soft Steel.	Medium Steel.
Tensile strength. Pounds per sq. in.	*50,000 to *60,000 **50,000 to 58,000**	*52,000 to *62,000 **52,000 to 60,000**	*60,000 to *70,000 **60,000 to 68,000**
Yield point, in pounds per sq. in. shall not be less than	*30,000 **28,000**	*32,000 **30,000**	*35,000 **33,000**
Elongation per cent. in eight inches shall not be less than.....	*26 **28**	25	22

actures

5. All fractures shall be silky and a dull fracture will be considered a failure of test.

difications in ngation for n and thick terial.

6. For material less than five-sixteenths inch (5/16″), and more than three-fourths inch (¾″) in thickness, the following modifications shall be made in the requirements for elongation:

6a. For each increase of one-eighth inch (⅛″) in thickness above three-fourths inch (¾″), a deduction of one per cent. (1%) shall be made from the specified elongation. *Recommended.*

No.	Sulphur	Phos.	Elong.	Reduction	Elastic Limit	Ultimate	Elong.	Reduction	Elastic Limit	Ultimate	Elong.	Reduction	Elastic Limit	Ultimate

Tensile Tests
Eye-Bars.

Bending Test

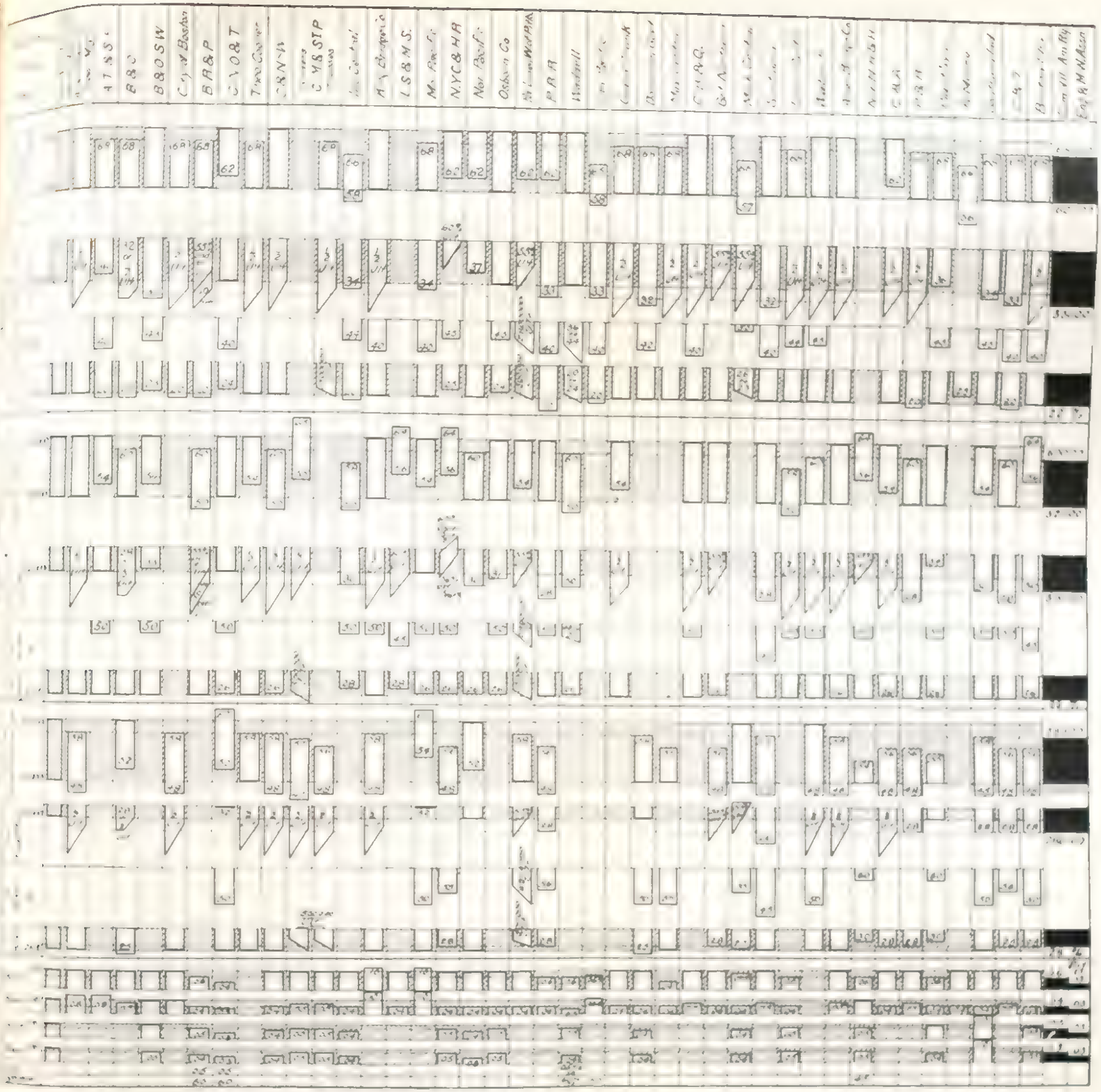


Fig. 1. Comparison of Requirements of 40 Specifications for Structural Steel.

6b. For each decrease of one-sixteenth inch (1/16") in thickness below five-sixteenths inch (5/16"), a deduction of two and one-half per cent. (2½%) shall be made from the specified elongation.

Recommended.

6c. For pins made from any of the three classes of steel, the required elongation shall be five per cent. (5%) less than that specified in paragraph No. 4, as determined on a test specimen, the center of which shall be one inch (1") from the surface. *Recommended.*

Tensile Tests of Eye-bars.

7. Eye-bars shall be of medium steel, and shall be annealed. Full-sized tests shall show twelve and one-half per cent. (12½%) elongation in fifteen feet of the body of the eye-bar, and the tensile strength shall not be less than 55,000 pounds per square inch. Eye-bars shall be required to break in the body, but should an eye-bar break in the head, and show twelve and one-half per cent. (12½%) elongation in fifteen feet and the tensile strength specified, it shall not be cause for rejection, provided that not more than one-fourth (¼) of the total number of eye-bars tested break in the head. *Recommended.*

Bending Tests.

7. *The three classes of structural steel for bridges and other structures shall conform to the following bending tests: and for this purpose the test specimen shall be one and one-half inches wide, if possible, and for all material three-fourths inch (¾") or less in thickness the test specimen shall be of the same thickness as that of the finished material from which it is cut, but for material more than three-fourths inch (¾") thick the bending test specimen may be one-half inch (½") thick:

Rivet rounds shall be tested of full size as rolled.

*(d). Rivet steel shall bend cold 180° flat on itself without fracture on the outside of the bent portion.

*(e). Soft steel shall bend cold 180° flat on itself without fracture on the outside of the bent portion.

*(f). Medium steel shall bend cold 180° around a diameter equal to the thickness of the specimen tested, without fracture on the outside of the bent portion.

*Omit.

Substitute for the above the following:

8. The three classes of structural steel here specified shall conform to the following bending tests, without fracture, on outside of the bent portion. The test specimen shall be one and one-half inches wide, if possible. For "soft steel" the specimen for bending tests shall have sheared edges, from which the sharp fins may be dressed off with a file, but otherwise the edges must be left as they come from the shears. For "medium steel" the specimens for bending tests may have the sheared edges planed or milled.

8a. For material more than three-fourths inch thick, the requirements for bending tests may be modified so as to allow bending tests to be made on specimens from the same melts of steel, but of less thickness. In such cases the thickness of the bending test specimen shall be not less than three-fourths inch, and may be made on specimens planed or turned to this thickness.

8b. Rivet steel shall bend cold 180° flat on itself.

8c. Soft steel shall bend cold 180° around a diameter equal to the thickness of the specimen tested, the test specimen to have sheared edges.

8d. Medium steel shall bend cold 180° around a diameter equal to the thickness of the specimen. The test specimen may have planed or milled edges.

Test Specimen for Tensile Test.

9. The standard test specimen of eight inch (8") gauged length shall be used to determine the physical properties specified in paragraphs Nos. 4 and 5. The standard shape of the test specimen for sheared plates shall be as shown by the following sketch:

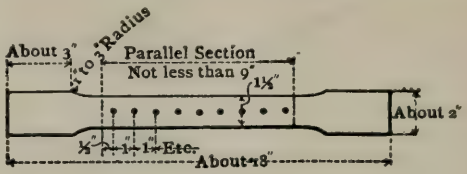


Fig. 2.

9a. For other material the test specimen may be the same as for sheared plates, or it may be planed or turned parallel throughout its entire length, and in all cases, where possible, two opposite sides of the test specimen shall be the rolled surfaces. Rivet rounds and small rolled bars shall be tested of full size as rolled. *Recommended.*

*9. One tensile test specimen shall be taken from the finished material of each melt, but in case this develops flaws, or breaks outside of the middle third of its gauged length, it may be discarded and another test specimen substituted therefor.

*Omit.

Substitute for the above the following:

Number of Tests.

10. At least one tensile and one bending test shall be made from each melt of steel as rolled. Also, at least one tensile and one bending test shall be made of each "variety" of material into which a melt is rolled. Each of the following shall constitute a "variety:" (1) Angles; (2) I beams, channels and Z bars; (3) universal plates; (4) sheared plates; (5) bars and rounds. Also steel differing in thickness more than 25 per cent. from that tested shall be separately tested. If more than ten tons is rolled from any melt for this order, then at least two tensile and two bending tests shall be made from the steel of such melt as rolled.

10a. If the ultimate tensile strength of any one test is above or below the prescribed limits of these specifications, by less than 2,000 pounds per square inch, two other tests may be made from the same lot of steel represented by such test. If these two last tests are within the limits of the specifications, the lot of steel will be accepted, otherwise it will be rejected.

10b. If the ultimate tensile strength of any one test is more than 2,000 pounds per square inch outside of the limits of these specifications, the lot of steel from which such test was taken shall be rejected without further testing.

10c. Not more than one test of either kind shall be made from a single piece of steel as rolled.

Test Specimen for Bending.

10. *One test specimen for bending shall be taken from the finished material of each melt as it comes from the rolls, and for material three-fourths inch (¾") and less in thickness, this specimen shall have the natural rolled surface on two opposite sides. The bending test specimen shall be one and one-half inches (1½") wide, if possible, and for material more than three-fourths inch (¾") thick, the bending test specimen may be one-half inch (½") thick.

*Omit.

11g. The bending test may be made by pressure or by blows.

Recommended.

Also add the following:

12. When nicked and bent 180° around a bar whose diameter is equal to the thickness of the rod, it shall not break with a sudden square break, but must show a gradual break and a fine, silky, homogeneous fracture. Nicked Tests o Rivet Steel.

13. Material which is to be used without annealing or further treatment shall be tested for tensile strength in the condition in which it comes from the rolls. For material which is to be annealed or otherwise treated before use, a full-sized section of tensile test specimen length shall be similarly treated before cutting the tensile test specimen therefrom. Annealed Test Specimen.

Recommended.

14. For the purpose of this specification, the yield point shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine. Yield Point.

Recommended.

15. In order to determine if the material conforms to the chemical limitations prescribed in paragraph No. 2, herein, analysis shall be made of drillings taken from a small test ingot. Sample for Chemical Analysis.

Recommended.

16. The variation in cross-section or weight of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations: Variation in Weight

16a. Plates 12½ pounds per square foot or heavier, when ordered to weight, shall not average* more than 2½ per cent. variation above or 2½ per cent. below the theoretical weight.

Recommended.

16b. Plates under 12½ pounds per square foot, when ordered to weight, shall not average* a greater variation than the following:

16c. Up to 75 inches wide, 2½ per cent. above or 2½ per cent. below the theoretical weight.

Recommended.

16d. 75 inches and over, 5 per cent. above or 5 per cent. below the theoretical weight.

Recommended.

16e. For all plates ordered to gauge, there will be permitted an average* excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

*Note: Would recommend that the words "average" be omitted and make these variations apply to single plates. (Com. A. R. E. & M. W. Assn.)

Table for Allowances for Overweight for Rectangular Plates When Ordered to Gauge.

The weight of one cubic inch of rolled steel is assumed to be 0.2833 pound. Plate one-fourth inch and over in thickness.

Thickness of plate. Inch.	Width of Plate. Up to 75 inches. Per cent.	75 to 100 inches, Per cent.	Over 100 inches. Per cent.
¼	10	14	18
5/16	8	12	16
⅜	7	10	13
7/16	6	8	10
½	5	7	9
9/16	4½	6½	8½
⅝	4	6	8
⅝	3½	5	6½

Plates under ¼ inch in thickness.

Thickness of plate. Inch.	Width of Plate. Up to 50 inches. Per cent.	50 inches and above. Per cent.
⅛ up to 5/32	10	15
5/32 up to 3/16	8½	12½
3/16 up to ¼	7	10

Recommended.

ish. 17. Finished material must be free from injurious seams, flaws or cracks, and have a workmanlike finish.

Recommended.

nding, 16. *Every finished piece of steel shall be stamped with the melt number, and steel for pins shall have the melt number stamped on the ends. Rivets and lacing steel, and small pieces for pin plates and stiffeners, may be shipped in bundles, securely wired together, with the melt number on a metal tag attached.

*Omit.

Substitute for the above the following:

18. Every piece of steel shall be stamped with the name of the manufacturer or mill at which it is made and the melt number and year; also the class of steel, whether "soft" or "medium." Steel for pins and forging shall be stamped on the ends. Rivet and lacing bars and small pieces for pin plates and stiffeners may be shipped in bundles, securely wired together, with the stamps on a metal tag attached.

19. Each piece of steel furnished under these specifications (except rivet rods and other small rolled bars) shall, before shipment, have branded cold upon it, by the manufacturer, this mark, AR in letters two inches high, by which the manufacturer shall denote that the material so branded has been tested by him in full accordance with the requirements of these specifications, and has successfully withstood all of the tests herein provided for, and is of such quality as is hereby required. In case of any piece of steel, after having been so branded, is condemned, for any cause whatsoever, then the brand shall be defaced by a ring stamp, thus: AR

pection. 17. *The inspector, representing the purchaser, shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

*Omit.

Substitute for the above the following:

20. The inspector representing the purchaser shall be afforded all necessary facilities by the manufacturer to satisfy him that the material is being made and furnished in accordance with the requirements of the specifications. It shall be his duty to see that the system of tracing the steel from the melt to the finished product is adequate and reliable. He shall witness all tension tests and keep a personal record of the same and shall, so far as practicable, satisfy himself that all tests are carried out in a bona fide manner. In cases of failure of tensile or bending tests, he shall require satisfactory evidence that the material condemned thereby is not, through negligence or for other reasons, shipped on contracts governed by these specifications.

21. The manufacturer shall furnish to the inspector, daily, if required, a correct list of all the steel rolled, on orders subject to his inspection, from every melt as rolled, indicating on this list from what pieces tests have been or will be prepared. The inspector shall satisfy himself that sufficient tests have been provided for, and after the tests have been made, he shall notify the manufacturer what material has been successfully tested and what, if any, has failed upon tests.

22. The manufacturer shall also furnish the inspector duplicate copies of the shipping bills or detailed lists of the material loaded for shipment, including melt numbers, etc., of all material upon orders subject to his inspection, and after the inspector has checked these with his records of tests and accepted material, he shall sign both copies and return one copy to the manufacturer and send the other copy to the railroad company he represents. If these shipping bills do not check with the inspector's records of tests and accepted material, he shall not sign them, and the shipment shall not go forward until the difference is rectified.

23. No material shall be paid for by the railroad company until the bill of shipment is checked and approved by the inspector.

24. The inspector shall have the right to make a surface inspection of any and all material under these specifications, and, when he so elects, the necessary facilities shall be afforded to him by the manufacturer. Whether the inspector makes a surface inspection of the material at the mill or not, no material having any injurious flaws will be allowed to become a part of any bridge or other structure, and in case any defective material is shipped from the mills it will be condemned at the shop, or bridge site, and will not be paid for, and will have to be replaced by the manufacturer without additional expense to the railroad company, for material, workmanship or other charges.

REPORT OF SUB-COMMITTEE NO 7E—DOCKS AND WHARVES.

One of the greatest industries in the United States, if not in the world, is the production and transportation of iron ore in the Lake Superior district of the States of Minnesota, Wisconsin and Michigan. To illustrate the magnitude of this great industry, I will quote the following

figures, taken from the Cleveland Iron Trade Review, at the close of the shipping season of the year 1900:

Location of Docks.	Shipments in tons.
Two Harbors, Minn	4,007,294
Duluth, Minn	3,888,986
Escanaba, Mich	3,436,734
Marquette, Mich	2,661,861
Ashland, Wis	2,633,687
Superior, Wis.	1,522,899
Gladstone, Mich	418,854
Total	18,570,315

These figures represent the shipments of iron ore for one year, and in looking back over the shipments of preceding years we find by the same authority that the shipments have doubled since the year 1896. We also find that a single mine, the Fayal mine of the Minnesota Iron Company's group of mines, shipped during the season of 1900 the enormous amount of 1,252,952 tons of iron ore.

To handle the great product of these Lake Superior mines expeditiously and economically, it has been found necessary to construct ore docks of special design to meet the varying requirements of the different grades of hard and soft ore. The first requisite of such a dock is the facility and rapidity with which the ore can be transferred from the ore pocket to the vessel. This has been accomplished experimentally in the different ore docks by the following procedure:

a—Varying the angle of slope of the floor of the pocket.

b—Varying the construction of the hoppers at the corners of pockets.

c—Varying the class of materials used in floors of pockets.

d—Varying the length and shape of the spouts or chutes.

e—By substituting an automatic counterbalanced hoist for the spouts or chutes, in place of the slow and expensive chain hoists used in the early construction of ore docks.

Taking up these different items in the order named, we find that (a) the angle of slope of the ore pocket has varied from an angle of 30 degrees to an angle of 50 degrees from the horizontal; the lesser angle was found by experience to be too flat for either hard or soft ores, and in the construction of new docks gradually changed according to the different ideas of engineers and dock superintendents, until the greater angle of 50 degrees was reached. This angle, in the opinion of the writer, is excessive for any grade of ore and causes too much of the horizontal component of the force of the load in the pocket to be exerted against the front of the pocket without gaining anything in return for the heavier construction thus required. The true angle of slope, according to the experience of the writer is 40 degrees for hard ores and 45 degrees for soft ores.

"b"—The original construction of the hoppers at the corners of ore pockets consisted of planks placed at an angle of 45 degrees and running

to the floor of the pocket. The details of construction of this form of hopper were weak in not recognizing the enormous load placed on them and not providing sufficient foundation, the result being excessive cost of maintenance. The flow of ore from the pocket to the chute was evidently across the grain of the wood, and the force of ore running over the hoppers and meeting the force of ore from the center of pocket caused a choking at the pocket door and a consequent delay and additional expense in discharging the ore into the chutes. This was overcome experimentally until we now have a timber 6x12 inches placed on edge on the floor of the pocket from the side of the door opening to the pocket partition, forming the base of the corner hopper, which is built of surfaced planks placed diagonally and at an angle of 60 degrees from the horizontal. The flow of ore is thus evidently *with* the grain of the timber and not *across* the grain, and a marked difference has been noted in the free discharge of the ore from the pocket.

"c"—Formerly large sheets of steel, with wing plates, were used in lining the floors of the pockets, the idea being that this would facilitate the discharge of ore from the pocket. Experience has demonstrated that the reverse of this idea is true, and that surfaced hard maple plank is a much better material to use than steel plate.

"d"—Formerly spouts or chutes of semicircular section and even depth were used, the result being that the first rush of ore from the pocket usually overflowed the sides of the spout and caused unnecessary waste. The flow of ore in the spout also caused excessive wear along the center line of the bottom. As a result of these conditions the spout has been increased in depth near the hinged end, and a flat section in the bottom has been substituted for the semicircular sections, thus distributing the wear over a larger surface. We have also added false bottoms to the spouts, which can be renewed without taking down the spout.

"e"—The manner of raising and lowering the spouts or chutes has been materially changed from the slow and man-killing process of the chain hoist to the modern, automatic, counterbalanced hoist. In the process of advancement much ingenuity has been displayed, and an inspection of the existing appliances on the different docks of the Lake Superior district would cause amusement even to non-professionals at the crude and poorly executed ideas of the different inventors. The original chain hoist consisted of a heavy and cumbersome system of pulleys, in which the idea of friction was apparently not considered, the result being a device that required the combined energies of four men for a period of five minutes to raise a chute weighing one ton to a position where it would clear the passage of a vessel along the face of the dock. Then came the Erickson hoist, with its poorly executed ideas, afterward incorporated into the Union hoist, another very crude appliance. Then came the Reed hoist, with an excellent idea, but badly executed by the manufacturers, indicating that they were selling cast iron by the pound at a good price. All of these devices were slow in operation, expensive in maintenance and dangerous to the lives of the employes who were required to operate them.

With the rapid growth of commerce came the demand for quicker dispatch at the ore docks and the consequent requirement of a hoist which would, after the pockets were emptied, permit the chutes to be raised in the shortest possible time to enable the vessel to move along the face of the dock to adjoining pockets, in order to receive the additional ore contained in them. The requirements of such a hoist were laid down as follows:

First—Absolute safety under all circumstances.
Second—Simplicity in construction.
Third—Automatic operation in raising the chutes.
Fourth—Minimum weight of counterbalance.

With these requirements in view, Mr. Daniel T. Denton of Duluth, Minn., who has contributed more to the production of a practical hoist than any other individual, went to work on the docks of the Duluth & Iron Range Railroad at Two Harbors, Minn., and with the writer made numerous experiments in the way of producing a safe and serviceable hoist. In these experiments they were ably assisted by Mr. J. L. Greatsinger, president of the railroad company, and who is also a thoroughly proficient mechanic. After repeated experiments the Denton automatic counterbalanced hoist was placed upon the market, and has now been adopted as standard by the following railroads:

The Duluth & Iron Range Railroad.
Chicago & Northwestern Railroad.
Duluth, Missabe & Northern Railway.
Great Northern Railway.
Lake Superior & Ishpeming Railway.
Spanish-America Iron Co., Cuba.

In the operation of the hoist the spout is wound down by one man in 30 seconds and is raised automatically by the weight of the counterbalance in 10 seconds.

In the construction of the dock proper numerous changes in design and materials have been made, according as experience in the operation of the older docks clearly pointed out the necessities. The dock has been increased in width to give additional stability and to provide room for additional tracks. The elevation of the hinge pin has been raised to meet the requirements of the largest types of vessels, and the height from hinge pin to base of rail has been increased to provide for the additional storage capacity required in each pocket. The length of the pocket has remained constant at 12 feet during all these changes on account of the fixed width between centers of the hatches of vessels (24 feet), thus permitting a vessel to take the ore from two sets of pockets by making one move of 12 feet along the face of the dock.

The installation of the electric light on the docks has made it possible to load vessels at night with quite as much safety as by day. An

arc circuit furnished current for the main lights, which are hung on brackets at intervals of 200 feet along the face of the dock, and an incandescent circuit furnishes current for the portable lamps to light the interior of the pockets while the ore is being discharged from them.

Fire protection is furnished by a wrought-iron main running along the interior walks of the dock, and hose connections are established at intervals of 200 feet on the upper deck, middle walk and lower walk. Convenient stairways, with short runs and frequent landings, are established to permit easy access to the different parts of the dock.

In the construction of the dock proper, Washington fir is used for door posts, partition posts, main sills, main caps and stringers, the price of this material now being about the same in the long lengths required as that of white pine, and a decided advantage being the facility of getting the timber of the dimensions wanted in a reasonable time, as well as the superior strength of the Washington fir for the purposes required. The remainder of the timber is white or Norway pine for posts and planks, hard maple for floor linings and white oak for pocket doors.

An idea of the magnitude of one of these ore docks can be had from the fact that in the construction of ore dock No. 5 of the Duluth & Iron Range Railroad there was required over 3,000 piles, of an average length of 40 feet, and 6,000,000 feet, board measure, of timber. The time occupied in completing this dock was five months, the work being started in winter when the piling could be driven from the ice, and completed on or about the first day of June.

A comparison of the different ore docks of the Lake Superior district has been made by Mr. Robert Angst, chief engineer of the Duluth & Iron Range Railroad, and this comparison appears in the appendix of this report. Additional information has been requested from the several railroad companies engaged in the shipment of iron ore. Some have replied, giving all the information asked for; others have answered, giving partial information, and several have made no replies at all. We hope by the time of the next convention to give complete tabulated reports of all the docks, as well as comparisons of cost per foot, cost per pocket, cost per ton of storage capacity, and cost of operation and maintenance.

Respectfully submitted,

W. A. McGONAGLE,
Chairman Sub-Committee No. 7E.

RECORD OF ORE DOCKS ON THE GREAT LAKES.

Railway.	Location.	Dock No.	Number of Pockets.	Storage Capacity, Tons.	Height Water to Center Hinge-hole.	Height Water to Deck of Dock.	Width of Dock Outside to Outside of Partition Posts.	Length of Spouts.	Length of Dock.	Angle of Pockets.	Remarks.
Chicago & N. W. Ry.....	Escanaba, Mich.....	1	184	24,104	28 ft. 10 in	48 ft. 6 in.	37 ft.	21 ft.	1104 ft.	39° 30′	
" " " "	" "	3	226	30,284	31 " 2 "	52 " 8 "	37 "	27 "	1356 "	45°	No. 2 taken down Feb., 1898.
" " " "	" "	4	250	32,750	36 " 6 "	59 " 2 "	37 "	30 "	1500 "	45°	
" " " "	" "	5	232	43,152	28 " 6 "	53 " 3 "	37 "	21 " 8 in.	1392 "	40°	
" " " "	Ashland, Wis.....	1	234	36,036	32 " 10 "	54 "	46 " 8 in.	27 "	1404 "	39° 30′	
" " " "	" "	2	234	25,740	36 " 6 "	57 " 8 "	46 "	27 "	1404 "	42°	
Duluth & Iron Range R. R.	Two Harbors, Minn.	1	202	40,400	35 " 5 "	59 " 6 "	49 "	27 "	1388 "	38° 42′	{ 312 ft. Single Pockets.
" " " "	" " "	2	208	41,600	33 " 5 "	57 " 6 "	49 "	27 "	1280 "	38° 42′	{ 1076 " Double "
" " " "	" " "	3	90	16,200	28 " 10 "	52 "	49 "	23 "	1572 "	38° 42′	
" " " "	" " "	4	168	30,240	28 " 10 "	52 "	49 "	23 "	1112 "	38° 42′	
" " " "	" " "	5	168	33,600	30 "	54 " 6 "	49 "	25 "	1112 "	38° 42′	
Duluth, Missabe & No. Ry.	Duluth, Minn.....	1	384	57,600	30 "	53 "	49 "	27 " 9 "	2336 "	45°	
" " " "	[St. Louis Bay.]	2	384	69,120	32 "	57 " 6 "	49 "	27 " 9 "	2336 "	45°	
" " " "	" " ...	3	192	40,320	40 " 7 "	67 " ½ "	59 "	27 " 9 "	1152 "	45°	
Duluth, So. S. & Atl. Ry...	Marquette, Mich....	1	270	27,000	25 "	45 "	40 "	20 " 4 "	1700 "	39°	
" " " " ...	" "	3	213	12,780	33 "	37 "	53 " 6 "	21 "	1200 "	39°	No. 3 Dock not in use.
" " " " ...	" "	4	200	28,000	27 " 9 "	47 " 3 "	36 " 8 "	21 " 1 "	1200 "	39° 45′	
L Sup. & Ishpeming Ry...	" "	1	200	36,000	30 " 9 "	54 "	50 "	24 " 7 "	1232 "	38° 40′	
Great Northern Ry.....	Superior, Wis.....	1	250	40,500	32 "	57 "	49 " 8 "	27 " 2 "	1525 "	45°	
" "	[Allouez Bay.]	2	250	62,500	40 "	73 "	62 " 8 "	32 " 4 "	1500 "	45°	
M., St. P. & S. St. Marie Ry.	Gladstone, Mich ...	1	120	15,000	26 " 8 "	47 "	37 "	21 " 8 "	752 "	40°	
Wisconsin Central Ry	Ashland, Wis.....	1	314	33,500	31 " 4 "	54 " 6 "	36 "	27 "	1908 "	{ 234 ft. 42° 30′ { 80 " 50° 45′	

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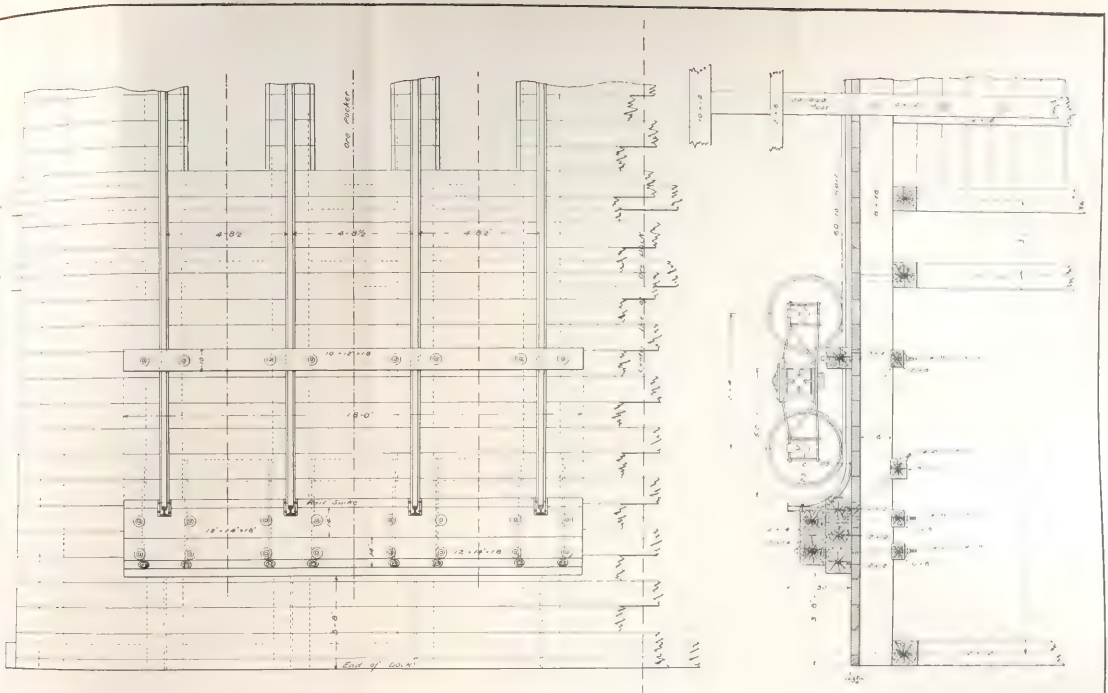


BILL OF MATERIAL.

TIMBER			IRON		
2	PCS.	12" × 14" × 18' 0"	8	MACHINE BOLTS	1¼" × 6' 2"
3	"	12" × 12" × 18' 0"	16	"	1¼" × 4'-6"
1	"	10" × 12" × 18'-0"	8	"	1¼" × 3' 7"
1	"	6" × 10" × 18' 0"	64	CAST IRON WASHERS	1¼" × 5"
3	"	6" × 6" × 18'-0"			

DULUTH & IRON RANGE R. R.

STD. BUMPER FOR ORE-DOCKS.

TWO HARBORS MINN.

Scale ½ in. = 1 ft. October 1901

WHARVES, PIERS AND DOCKS FOR GENERAL FREIGHT PURPOSES.

BY J. P. SNOW.

The general arrangement of facilities for loading and unloading vessels at the harbors of this country and Europe are quite different. Plate 1 shows at a small scale two typical layouts for piers at New York and a portion of the docks at Liverpool, England. The East River scheme, with piers from 40 to 80 feet wide by 450 to 600 feet long, with docks between them 150 to 200 feet wide, is for coastwise vessels, while that on the North River is for transatlantic trade. Here the piers are 125 feet wide by 800 feet long, with docks 250 feet wide between them. These schemes are types of the general layout for the two sides of Manhattan Island. There is some 3¼ miles of front on the East River and 2¼ miles on the North River treated in this way, with a further extension of three miles under consideration on the North River. This construction is typical of American harbors where much business is done. It will be seen that the system consists of a series of piers projecting into the water more or less at right angles to the shore line, with water space between them where vessels may be tied up. European custom, on the other hand, is to form large basins communicating with the main harbor by narrow passageways provided with lock gates. The walls of these basins are generally stone or concrete masonry and form quays or wharves against which vessels lie while handling cargo. The entrance gates are generally double to prevent trouble in case one should be staved by accident. The water within is kept at high tide level, passage being made only at high water.

The European method has the advantage of keeping the vessel at a nearly constant height, while at American piers they ride up and down with the tide. At Liverpool the range of tide is 21 feet, while at most American ports it is but 6 to 12 feet.

In what follows, a wall that is parallel to the shore against which vessels lie will be called a wharf or quay, a structure projecting out into the water built for vessels to lie against will be called a pier, and the shore wall across the heads of these piers will be called the bulkhead. The water between two piers will be called a dock.

The construction of American piers and wharves varies all the way from log cribs to masonry walls. A few type cases only will be described.

Log cribs mark the first attempt at building a boat landing in a timber-growing country, and the practice has been extended to quite large constructions at some points.

The Maine Central Railroad has at Bangor log-crib wharves, with 40 feet of water at their front. The general construction is shown on Plate 2, Fig. 1. The cribs should be filled with stone to high-water level, at which point they are covered with logs close together and filled with earth ballast to the height required. The front above water is cribbed with square timber and cedar ties, as shown. The width of crib should

equal the height. These crib walls sometimes crowd forward, the logs parallel to the front rolling or crushing over, due to insufficient area of bearing. This failure could probably be prevented by sizing the transverse logs and filling the spaces between them with long chocks, drift-bolting them thoroughly.

The Chicago, St. Paul, Minneapolis & Omaha Railway have built crib piers at Superior, Wis., as shown on Plate 2, Fig. 2. The timber is sawed white pine. The 3x12 upright chocks between the transverse timbers are for the purpose of preventing the breakage of the timbers by the filling. 20 feet of water is obtained at these piers; they are 150 feet wide by 1,700 feet long, and have warehouses 80 feet wide built on them.

A very common wharf wall in the vicinity of Boston is shown on Plate 2, Fig. 3. The stone wall is started at low-tide level on natural earth, riprap or pile foundations, as called for by the nature of the ground, and a pile platform built in front of it wide enough so that the slope from the foot of the wall to the required depth of dredging at face of wharf will not be steeper than 1½ horizontal to 1 vertical, with a few feet margin for berm. The slope may be covered with small stone to prevent wash by the water. If it is probable that greater depth of water will be needed at some future time, the whole construction should be set back from the prescribed bulkhead or wharf-line, so that pile-work can be added to the face of the work and the bottom dredged lower without making the slope in front of the sea wall steeper.

This style of construction is used for piers as well as wharves, where they are wide enough to make it applicable. Plates 3 and 4 show a pier built by the state of Massachusetts on its South Boston flats, where this style of front was used.

Plate 10 is another example of similar work under a two-story freight shed.

Fig. 5, Plate 2, shows a dock wall built by the Illinois Steel Company at South Chicago. The drawing is copied from a cut in Engineering News, Vol. 42, page 378; it explains itself. It consists essentially of a concrete wall on a pile foundation, the earth below water being retained by a bulkhead of sheet piling. The thrust is resisted by rod anchors, as shown, and by the inclined piles. Bracing piles inclined against the thrust could not be driven with as much batter as was desired, so tension braces were used. They are firmly bolted into the pile platform. All the foundation timber work is below water. The fender piles are 12 feet apart and the oak timbers cut in between them are held by bolts set in the concrete. The cast-iron mooring posts are 48 feet apart and are strongly anchored by rods buried in the concrete. The concrete is made of Steel Portland cement, sand and furnace slag. The drift bolts in the capping are left standing 9 inches above the timber to secure a bond with the concrete. The account in Engineering News referred to above states that this style of construction is patented by its designer, Mr. Victor Windett.

A sheet piling bulkhead, with more or less pile platform in front anchored back to a hold-fast in the ground, similar to the above wharf but with no masonry top, is a cheap construction for a wharf front when no more than 12 to 16 feet of water are needed.

Fig. 6, Plate 2, is the cross-section of a bulkhead wall being built by the North German Lloyd Steamship Company at Hoboken, N. J. The piles are 3-foot centers, cut off 24 feet below mean low water and filled to their tops with fine cobbles or gravel. A timber crib, 24 feet high, is then sunk on the piles, the bottom of which, consisting of two courses of 12-inch timbers, is wide enough to cover the piles, while the sides are set in 3 feet on each side. The sides are built solid of 6x10, laid flat. Near the center there is a longitudinal wall of 6 inches by 6 inches and at 10-foot intervals cross-walls of the same. These walls are laid solid for 6 feet from the bottom, above which they are laid 6 inches open. Three-inch by 8-inch diagonal braces are spiked to these walls, as shown.

The crib is filled with Portland cement concrete. The front face above low water is granite ashlar masonry with concrete backing. Coarse stone riprap is to be placed at front and rear. The vessel's prow shown in outline is the forefoot of the Kaiser Frederick. This drawing, as well as Fig. 7, is taken from a description of the American terminal of the above-named company, by their engineer, Mr. William F. Whittemore, associate member American Society Civil Engineers, given in Engineering News, Vol. XLV, p. 13.

The bulkhead walls of New York harbor are built with large base blocks of concrete, resting on piles, with a granite face wall above water, backed with concrete placed in situ. Fig. 4, Plate 2, shows a typical section.

The mud is dredged to 16 feet below low water; piles are driven about 3 feet apart lengthwise of the wall, except the front row, where they are 1½ feet apart. They are 2 feet 3 inches to 2 feet 9 inches apart across the wall. They are generally red or Norway pine, and must be not less than 12-inch diameter where cut off. A circular saw on a long, adjustable shaft, attached to a floating pile-driver, is used for cutting them off. The soft mud is pumped or washed away from between the piles and for a space in front down to firm material, and the space filled with cobble stone to the heads of the piles. Mortar in sacks made up like mattresses is then placed on the pile heads by divers, and the concrete blocks lowered to place. These blocks are made in forms of Portland cement mortar and broken stone, and are set with a powerful floating derrick. The blocks are 6 feet long in line of the wall; the joints between them at top are stopped with oakum, and the granite dimension stone facing set in mortar in the usual way. The backing of this top wall is concrete, rammed in place between tides.

The style of construction is varied; the base block is sometimes made in two parts, being divided about midway of its height, so as to enable them to be handled with less expensive machinery.

Foreign quay walls are built with stone or concrete masonry; sometimes by means of cofferdams, but often in sections on pneumatic caissons.

Piers are generally built of pilework. Plate 5 shows a pier, 35 feet wide, designed by the Massachusetts Harbor and Land Commission, to be used by a coal-unloading and conveying plant.

The piles are oak and all sawed timber Southern long leaf pine. It will be noticed that in this and other wharf constructions around Boston harbor, spur piles are freely used to brace the structures against side thrust. In many parts of the country plumb piles are depended upon altogether for this purpose. It is a debatable question which method is most efficient. In situations where the shocks are likely to be great enough to drive spur shores or to lift the plumb piles to which they are attached, it is probable that it is better to use plumb piles only and allow the structure to sway. This condition obtains in guide racks for ferry-boats, as shown on Plate 16. On the other hand, where swaying would be detrimental to the structures, spur piles will undoubtedly hold the structure more rigidly than plumb ones, if there are enough of them so that they shall not be overloaded. It is advisable to head them into the plumb piles above or below the point where the side pressure is applied, so as to get the advantage of as much spring action as possible.

The braces on the piles shown on Plates 3 and 5 are small oak sticks hewn on one side. They are much better than sawed sticks. Some engineers prefer drift bolts to screw bolts for securing the braces to the piles. Drift bolts, 1-inch diameter, can be driven into a ⅞-inch hole, while a 1-inch screw bolt requires a hole to be bored 1 1-16 inches. The full strength of the iron will be developed if a drift is properly driven 8 inches into an oak pile. The best results are obtained from drift bolts with points merely hammered around to chamfer the end slightly, and heads rounded and forged in the neck to fit a ½-inch countersunk washer. If square heads not countersunk are used, heavy blows in driving are apt to break them off.

Plate 6 shows sections and details of Pier 29, East River, New York. This pier happens to carry a sewer, which is shown on the cross-section. The pile bents are generally 10 feet on centers, except at the outer end, where they are made double and spaced 23 feet, as shown. The double bents are faced on their inner sides and a tight course of 6-inch plank bolted between them from mean low water to the caps. At the ends of the bents the three outer piles are faced to a uniform width of 34 inches and sheathed with 4-inch plank. By means of chocks and fillers these end piles are made to form a solid mass oval in horizontal section, and are then covered with ½-inch boiler iron, as shown on detail. This armature extends from the underside of the cap to 5 inches below mean low water. The purpose of the wider spacing between bents near the end of pier and the iron protection is to pass ice without risk of damage to the structure in the strong tides that run crossways of these piers.

The interior piles are white, yellow and Norway pine or cypress, 60 to 75 feet long; the fender piles white oak; the timber and deck planking yellow pine and the sewer staves 4-inch creosoted spruce. The 4-inch course of under-deck planking is laid square across the pier, with joint 2 inches open, except over the caps, where it is laid close; the 3-inch top course is laid tight. For a width of about 16 feet 9 inches on each side of the pier the top is laid parallel to the side of the pier; the central portion is laid at an angle of 45 degrees. This construction is typical of all the piers lately built by the Department of Docks and Ferries of New York City, both on the North and East rivers.

Fig. 7, Plate 2, shows a section of one of the piers now being built by the North German Lloyd Company at Hoboken, N. J. There are three of these piers, two being 80 feet wide and one 90 feet; they average about 888 feet long. The bents are 9 feet on centers, and the piles in the bents for about two-thirds of the length of the pier from the shore end 6 feet on centers. The outer third has them 3 feet on centers, and the five outer bents are double. The piles are generally 85 to 90 feet long, and in the outer 300 feet about one-half the piles are reinforced by 4 pieces of 6x6 timbers, 30 feet long, spiked and bolted to them. The deck planking, deck timbers and stringers are creosoted. The 8x8 oak sheathing at the sides of the pier is continuous on both sides and around the ends. It is grooved for 2x4-inch yellow pine splines, and with the concrete deck covering is expected to prevent fire from getting at the substructure. The 2-inch finish floor is tongued and grooved.

Pier corners are very difficult to keep. Plate 7 shows a few different designs that have been used. Fig. 1 is quite simple and has been used with good results on draw bridge fender piers and wharves. It is used where the face of the pier is sheathed with horizontal planking. Fig. 2 shows the corner of Pier 29, East River, New York, described above. Fig. 3 is a plan view of the corners of the 35-foot pier at South Boston, shown generally on Plate 5. Fig. 4 shows the corners of the South Boston pier, of which Plate 4 is the general plan. Fig. 5 shows the corner construction of the North German Lloyd piers at Hoboken.

All piers and wharves against which vessels are expected to lie should have fender piles on their faces, unless they are heavily sheathed like Fig. 7, Plate 2. Unless horizontal chock timbers are cut in between these fender piles, as shown on Plate 6 and Fig. 5, Plate 2, they are very likely to be knocked out by square-nosed lighters and other vessels when moving parallel to the wharf. These chock timbers to be effective must be backed up by substantial timbers secured to the piling.

Wharf work built in Southern waters must be protected from the teredo by creosoting or otherwise. But little trouble is experienced from this animal at New York or Boston. At the latter port, however, the limnoria is quite active in certain locations. Its action, however, is slow and little is done to protect timber from its ravages. Creosoting and kyanizing are used to some extent for preserving timber

above water from decay. It is, however, not very generally done, and unless the preserving process is under control so as to insure thorough work, it is questionable if better results cannot be obtained by selecting all heart stock for the important parts of the structure where it will be expensive to renew and using the sappy timber where it will wear out rather than decay and where it can readily be renewed. Creosote and other antiseptic washes are effective in preventing decay where timber is protected from the sun and fresh water.

FREIGHT SHEDS.

These structures vary all the way from mere weather shelters to many storied fireproof warehouses. A few types only will be described.

Plate 8 shows a pier shed 375 feet long by 80 feet wide, at New London, Conn., owned by the New York, New Haven & Hartford Railroad, and used by the steamers running between that port and New York. The center posts and roof trusses are 10 feet apart. The doors are 16 feet wide by 10 feet high and spaced to fit the gangways of the particular vessels using this pier. Trussed framing is used under the ends of trusses that come over doorways.

Plate 9 shows the cross-section of a shed 700 feet long by 170 feet wide, at the Mystic wharf water front of the Boston and Maine Railroad. The posts are 34 feet apart lengthwise of the building and carry longitudinal trusses as well as the tranverse trusses shown. These longitudinal trusses carry intermediate transverse trusses so that the purlin supports are 17 feet apart. The doors on the track side are 10 feet wide by 8 feet high and 34 feet apart on centers. On the water side the doors are 16 feet wide by 16 feet high and 34 feet on centers.

The house is arranged to be entered by teams from the street and the arrangement of posts allows large teams to drive to any part of the shed. The floor is supported on brick piers spaced 8 feet six inches by 10 feet six inches. This shed is used for general freight in and out, handled by coastwise and transatlantic steamers.

Plate 10 shows the section of a two-story shed on Pier No. 4, South Boston, belonging to the New York, New Haven & Hartford Railroad. The upper floor is used for storage. The posts are 16 feet apart lengthways of the building and the pile bents of the wharf 8 feet. The lower story has continuous sliding doors along the dock. They are hung outside and inside alternately, and are 16 feet high. The drawing shows one-half the width only. The shed is planned to be 196 feet wide by 481 feet long. The 31-foot clear space is for the accommodation of wagons.

Pier sheds are often built with iron frames. Plate 11, Fig. 1, shows one now under construction by the New York, New Haven & Hartford Railroad at Pier 31, East River, New York. It is 404 feet long with 53 feet 6 inches of the shore end built two stories high for office purposes. It has doors 16 feet wide by 13 feet 3 inches high, generally 40 feet apart on centers. The roof trusses and column bents are

20 feet on centers. Fig. 2, same plate, shows an iron shed owned by the same railroad on Pier 18, North River, New York. It is somewhat similar to Fig. 1, but has a large monitor the whole length of the roof fitted to carry a footwalk for the use of passengers. Both these sheds are for the use of Long Island Sound steamers running to New London and other Sound ports. On most of the older wharves passengers and freight are landed on the same floor, and freight teams, hand trucks, light carriages and pedestrians are indiscriminately mixed.

The purpose of the footwalk on Pier 18 is to furnish a safe passageway for passengers clear of the freight traffic. Stairways in the two-story head house and at a point near the steamer's gangway furnish easy access to the walk.

Fig. 3, Plate 11, shows a pier shed lately designed for Pier 33, East River, New York. The roof bents are 20 feet apart. The columns are peculiar in having an inner and outer section with a space of 5 inches between them where the sliding doors run.

Fig. 1, Plate 12, shows a two-story iron shed now being built for the New York Central Railroad on pier at foot of West Fifty-ninth Street, New York. It is 680 feet long and is wholly for freight use. The upper floor is for storage. The doors are 12½ feet wide by 13 feet 3 inches high, and 40 feet on centers in the lower story and 80 feet apart on the second floor. The sides of the building are covered with galvanized corrugated iron fastened directly to the iron framework and the roof is covered with tarred felt and slag roofing. A railroad track runs the whole length of the shed on the lower floor. The four sheds shown on Plate 11 and Fig. 1, Plate 12, are built directly on the decks of piers constructed like that shown on Plate 6, with additional foundation piles, generally two at each post.

Fig. 2, Plate 12, shows the cross-section of the sheds to be built on the new piers of the North German Lloyd Steamship Company docks at Hoboken, N. J. The upper floors of these sheds are wholly for passengers and baggage and the lower floor for freight. The second story of the bulkhead building connecting these pier sheds is arranged for waiting and baggage rooms, station office, etc.

The columns are 18 feet apart and the main roof girders carry the second floor by two lines of hangers. The columns are cased with cast iron and packed with cement concrete, and galvanized sheet-iron arches are sprung between the bottom flanges of the roof and second floor I beams and filled with cinder concrete for protection against fire. The sides between the columns are wood sheathing covered with tin. The lower floor construction is shown on the sketch of Pier Fig. 7, Plate 2. The second floor has a 3-inch tongued and grooved yellow pine base, waterproofed with 3-ply felt and asphalt roofing cement, covered with asbestos felt, over which is laid a finish floor of ⅞-inch matched maple The roof is 3-inch tongued and grooved pine covered with tar and gravel roofing.

The sides of these sheds batter ½ inch per foot, like most of the older pier sheds about New York. This is mainly for the purpose of allowing room for a line of masts or derrick poles set in the sides of the pier, between the tops of which, at a height above the floor (in this instance) of about 60 feet, a wire cable is stretched to which tackles are hitched for handling freight in and out. These masts are strongly stepped in the pilework at low-water level and are back-stayed to the roof of the building.

Freight sheds of more than one story are generally provided with some appliance for raising and lowering goods, but none of those here described are as yet fitted with anything of moment in this line. Single whip hoists with slings or hooks, worked from drums connected by friction clutches to a shaft running through the building, are used in many places, and continuous conveyors, with arms capable of taking barrels or bales to any desired height, are sometimes used.

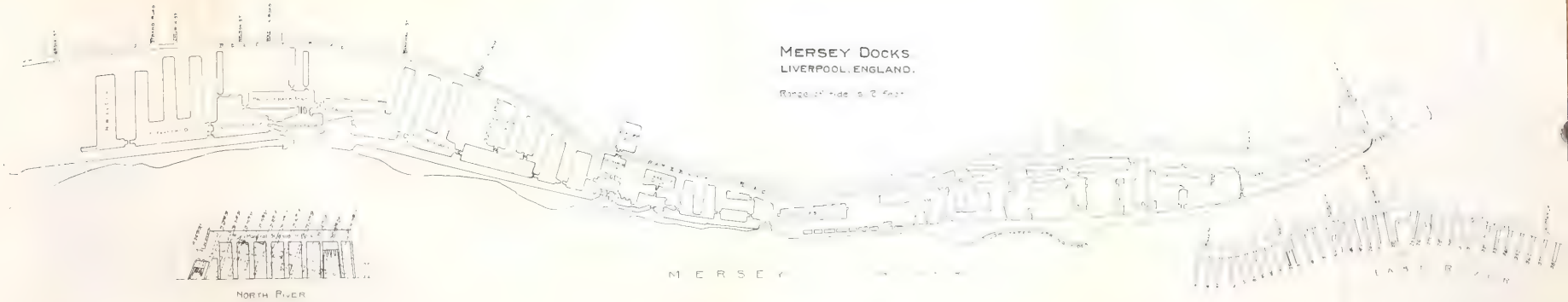
The many appliances for using power to handle freight in and out of vessels, wharf drops for accommodating decks at low tide, the arrangement for Customs officers while inspecting freight and baggage and the precautions provided for the health officers and commissioners while rounding up the great droves of immigrants would be interesting subjects for description, but they cannot be covered in this already too long report.

TRANSFER FLOATS, FERRIES AND BRIDGES.

Transfer facilities are needed where it is desired to carry cars across a stream or about a harbor or to place them along the outside of a vessel while she is discharging cargo at a wharf. They consist of a drop bridge hinged at the shore end and supported at the outer end on some adjustable appliance, and a float or ferry boat on which tracks are laid to match those on the drop bridge.

Floats used simply for ferrying freight cars may be of any size; carrying one, two, three or four tracks, depending on the arrangement of the drop bridge. Most of this class of floats in New York harbor have three tracks, while the bridges have but two; the middle track on the float being curved at the bow to match one of the tracks on the bridge. Floats designed for carrying cars to be unloaded directly into vessels can have but two tracks, and they should be not less than 18 feet on centers. They must have a platform between the tracks at the level of the car floors on which to wheel freight from the various cars. A three-track float can be readily converted to a lightering float by building a platform over the middle track. It will be somewhat wider than is economical for a permanent lighter, but has the advantage of being interchangeable for both classes of service.

Many car ferry boats are fitted with motive power so as to be self-propelling, but the ordinary freight car float is a simple scow, propelled by a tug boat lashed alongside. Their length varies from 4 to 6 car-lengths; most of them being of the latter size and carrying 17 cars as a full load on three tracks.



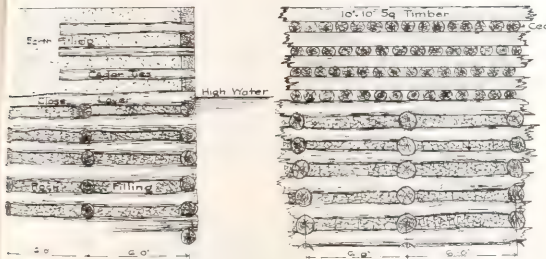
MERSEY DOCKS.
LIVERPOOL, ENGLAND.

NORTH RIVER PIERS.
NEW YORK, U.S.A.

EAST RIVER PIERS.
NEW YORK, U.S.A.

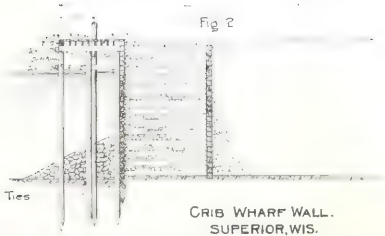
PLATE I

Fig 1



LOG CRIB WHARF

Fig 2



CRIB WHARF WALL.
SUPERIOR, WIS.

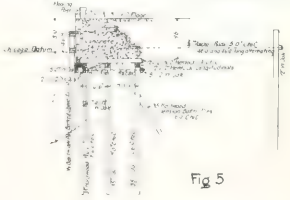


Fig 5

LOCK WALL FOR ILLINOIS STEEL CO
SO. CHICAGO.

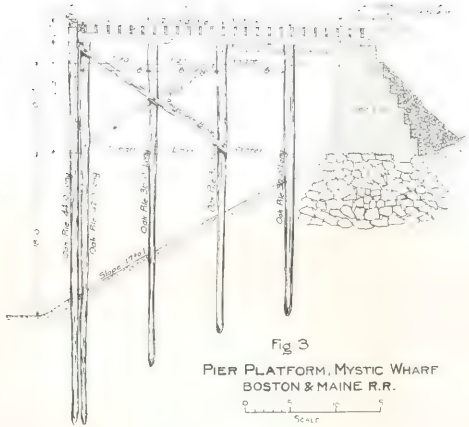
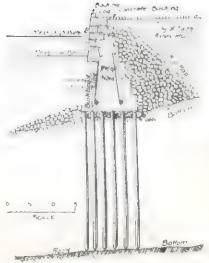


Fig 3

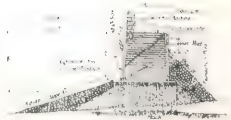
PIER PLATFORM, MYSTIC WHARF
BOSTON & MAINE R.R.

Fig 4



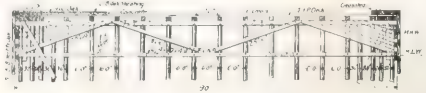
BULKHEAD WALL.
NEW YORK DEPT. OF DOCKS

Fig 6



BULKHEAD WALL
NORTH GERMAN LLOYD S.S.CO.
HOBOKEN, N.J.

Fig 7



CROSS SECTION OF PIERS.
NORTH GERMAN LLOYD S S CO.
HOBOKEN, N.J.

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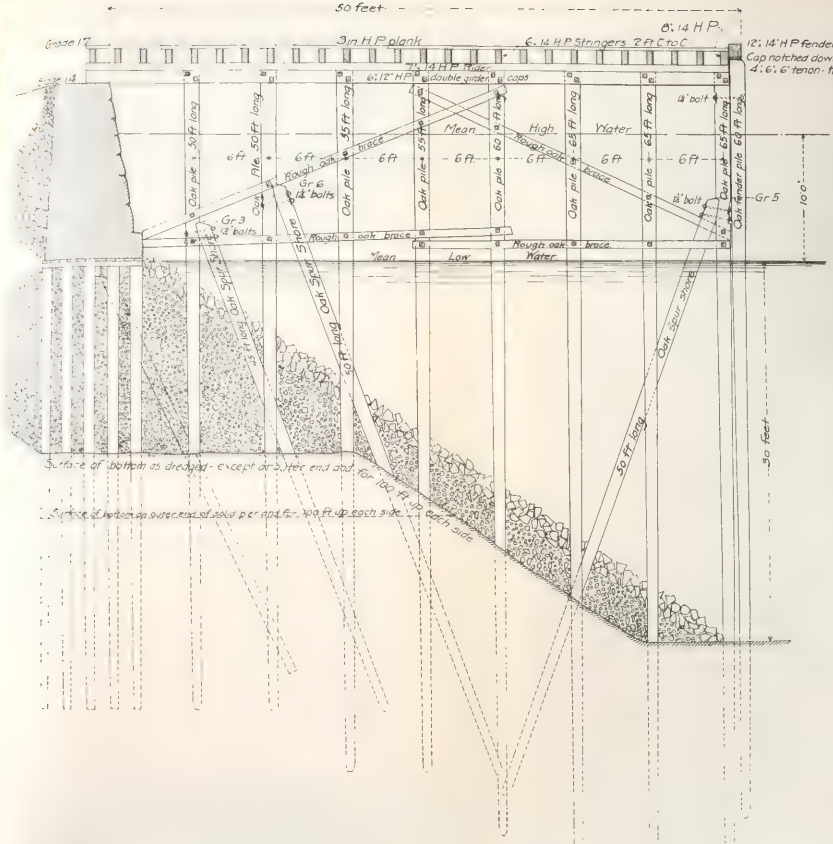
UNIVERSITY OF ILLINOIS
URBANA


50 feet
Grade 17
3 in H P plank
6. 14 H P Stringers 2 Ft C to C
6. 14 H P.
12. 14 H P fender cap
Cap notched down on pile 2 inches.
4. 6. 6" tenon - free nailed
7. 14 H P Piles
6. 12" H P double girders caps
14' bolt
Oak pile 50 Ft long
Oak pile 55 Ft long
Oak pile 60 Ft long
Oak pile 65 Ft long
Oak fender pile 60 Ft long
Mean High Water
6 ft
Rough oak brace
Gr 6 14" bolts
Gr 3 14" bolts
Gr 5
10 ft
Oak Spur strut
Rough oak brace
Mean Low Water
Oak Spur strut 50 Ft long
30 feet
Surface of bottom as dredged - except at outer end and for 100 ft. up each side
Surface of bottom at outer end of solid pier and for 100 ft. up each side

COMMONWEALTH OF MASS. PIER AT SOUTH BOSTON.

SCALE 0 5 10 15

PLATE 3.

1200 feet
Bents 8 Ft apart - piles 6 Ft apart in bents throughout
23 fender piles in corner not shown on plan
Sea Wall
1150 feet
F I L L I N G.
300 feet
Sea Wall
400 feet
Sea Wall
23 fender piles in corner not shown in plan

COMMONWEALTH OF MASS. PIER
AT
SOUTH BOSTON.

0 50 100 150
Scale

PLATE 4

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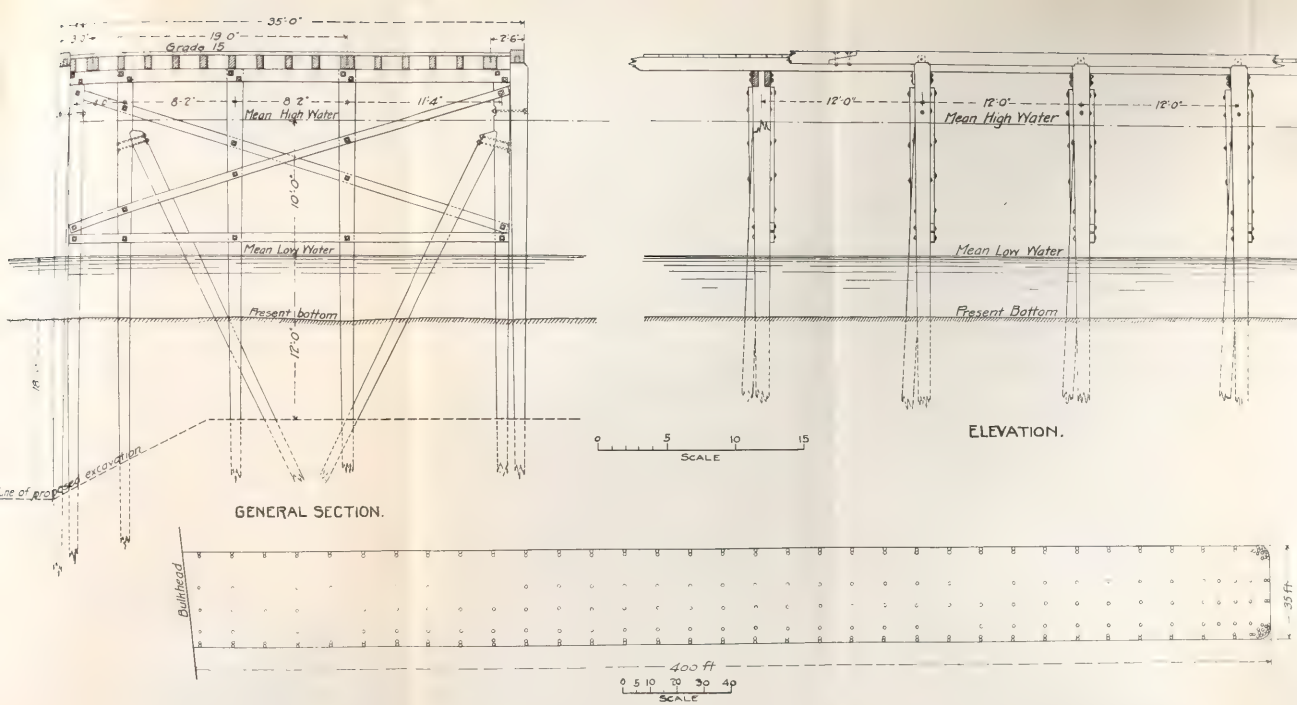
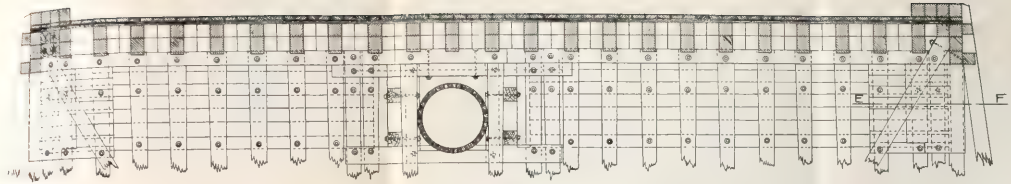
URBANA



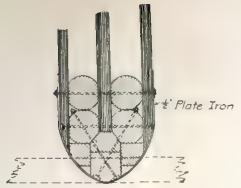
35 FOOT PIER.

SO. BOSTON, MASS.

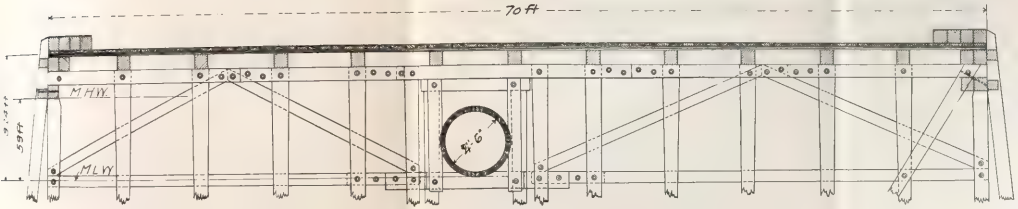
PLATE 5.



SECTION A-B.

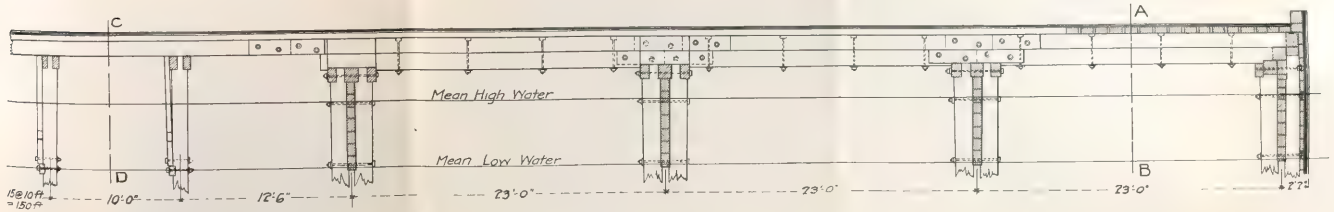


SECTION E-F.



SECTION C-D.

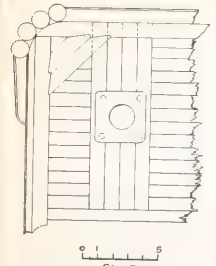
PIER No. 29. EAST RIVER, NEW YORK.



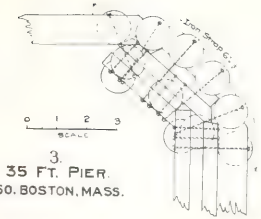
LONGITUDINAL SECTION.

PLATE 6

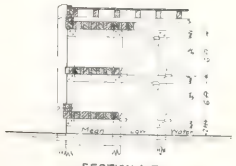
1.
B&M.R.R. MYSTIC WHARF.



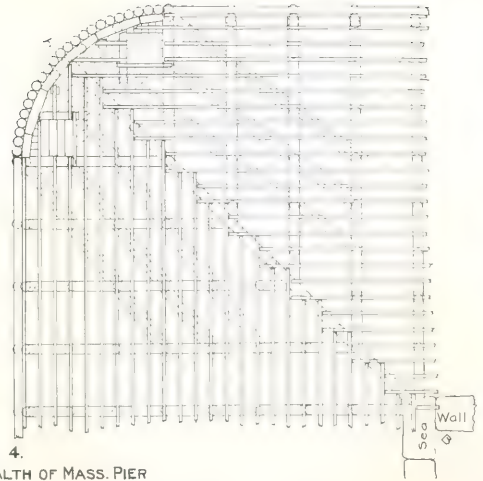
2.
PIER No. 29, EAST RIVER,
NEW YORK.



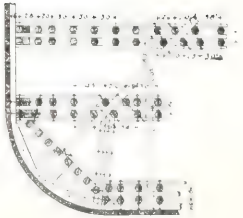
3.
35 FT. PIER.
SO. BOSTON, MASS.



SECTION A-B.



4.
COMMONWEALTH OF MASS. PIER
AT
SOUTH BOSTON.



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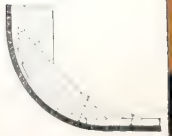
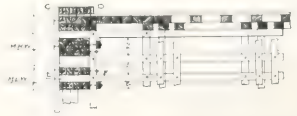
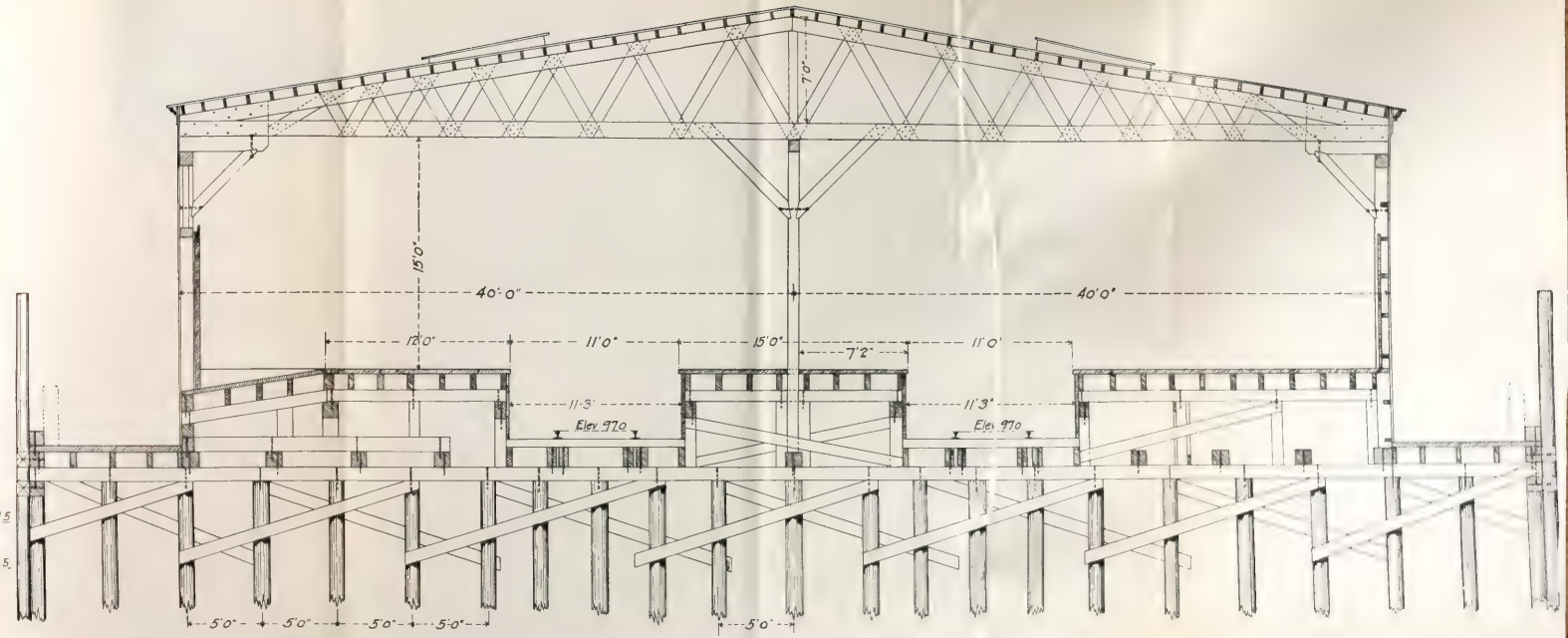


SECTION C-D.



5.
NORTH GERMAN LLOYD S.S. CO'S PIERS.
HOBOKEN N.J.

PLATE 7



MHD 915

MLW 885

FREIGHT HOUSE OF N.Y.,N.H.& H.R.R.
NEW LONDON, CONN.

SCALE 0 5 10

PLATE 8

1

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d
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-
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l
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e
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-
1
t
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1
e
s
f

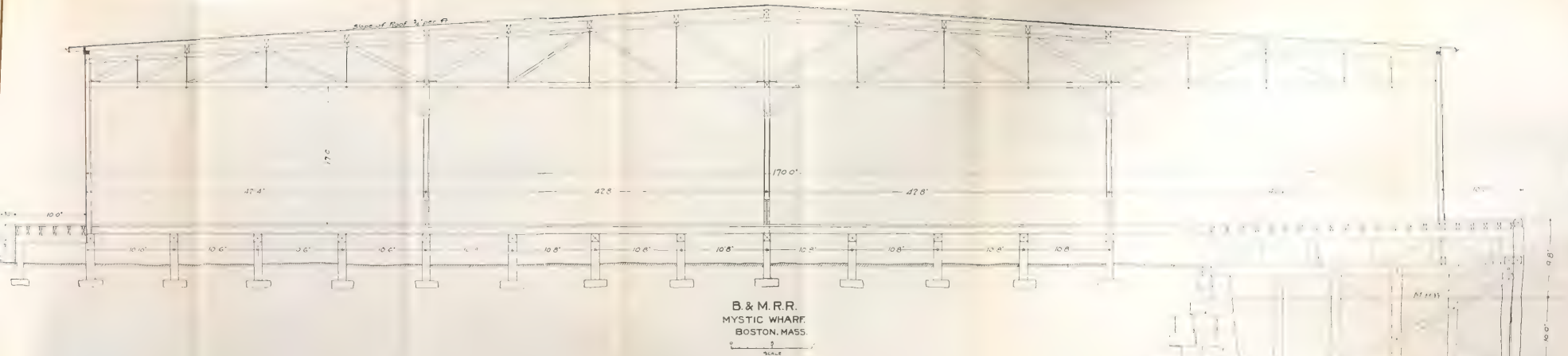
Slope of Roof 3" per ft
170'
42'4"
42'8"
42'8"
170.0'
10'0"
10'10"
10'6"
10'6"
10'6"
10'8"
10'8"
10'8"
10'8"
10'8"
10'8"
10'8"
B. & M. R.R.
MYSTIC WHARF.
BOSTON, MASS.
SCALE
M.H.W.
M.L.W.
9'8"
10'0"

PLATE 9

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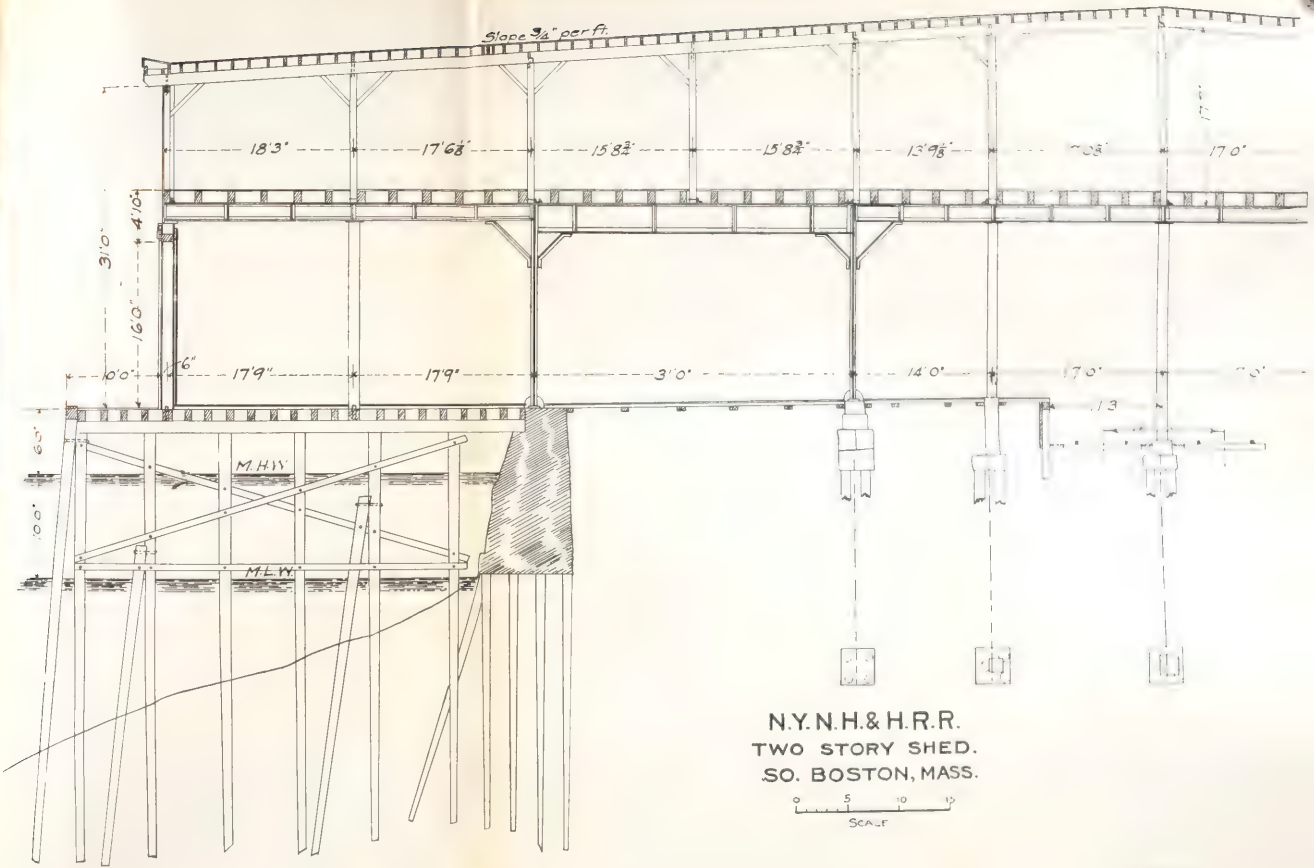
URBANA



N.Y.N.H.& H.R.R.
TWO STORY SHED.
SO. BOSTON, MASS.

0 5 10 15
SCALE

PLATE 10.

1

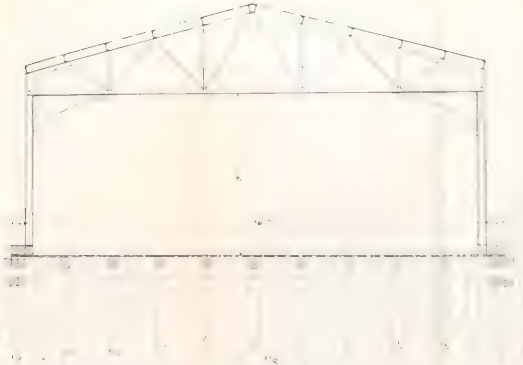


Fig 7
N.Y.N.H.& H.R.R.
PIER NO. 31, EAST RIVER
NEW YORK

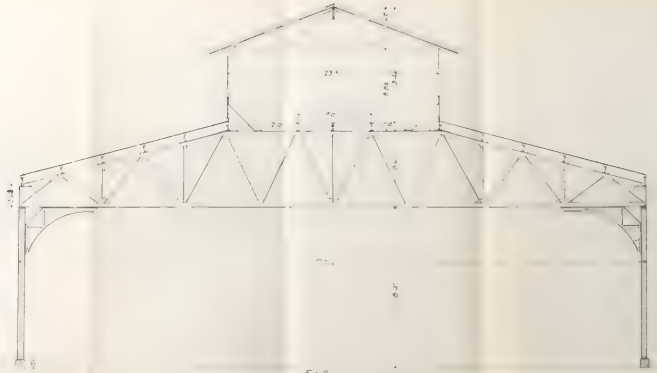


Fig 8
N.Y.N.H.& H.R.R.
PIER SHED NO. 18, NORTH RIVER,
NEW YORK

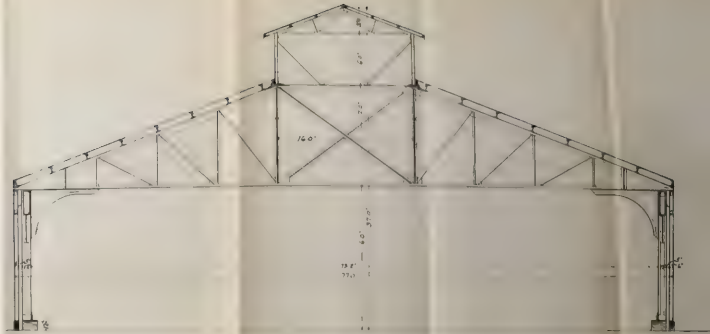
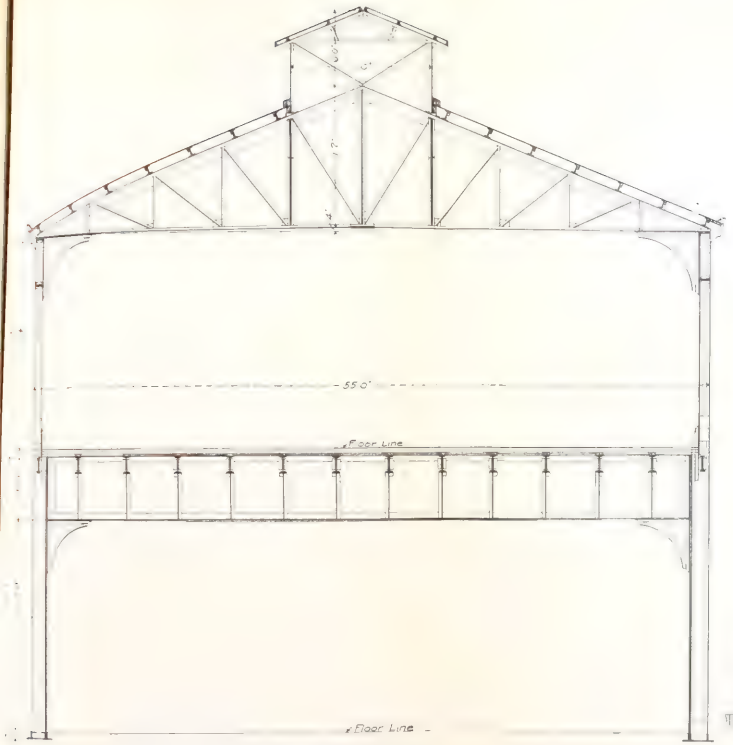


Fig 9
N.Y.N.H.& H.R.R.
PIER NO. 33, EAST RIVER,
NEW YORK.

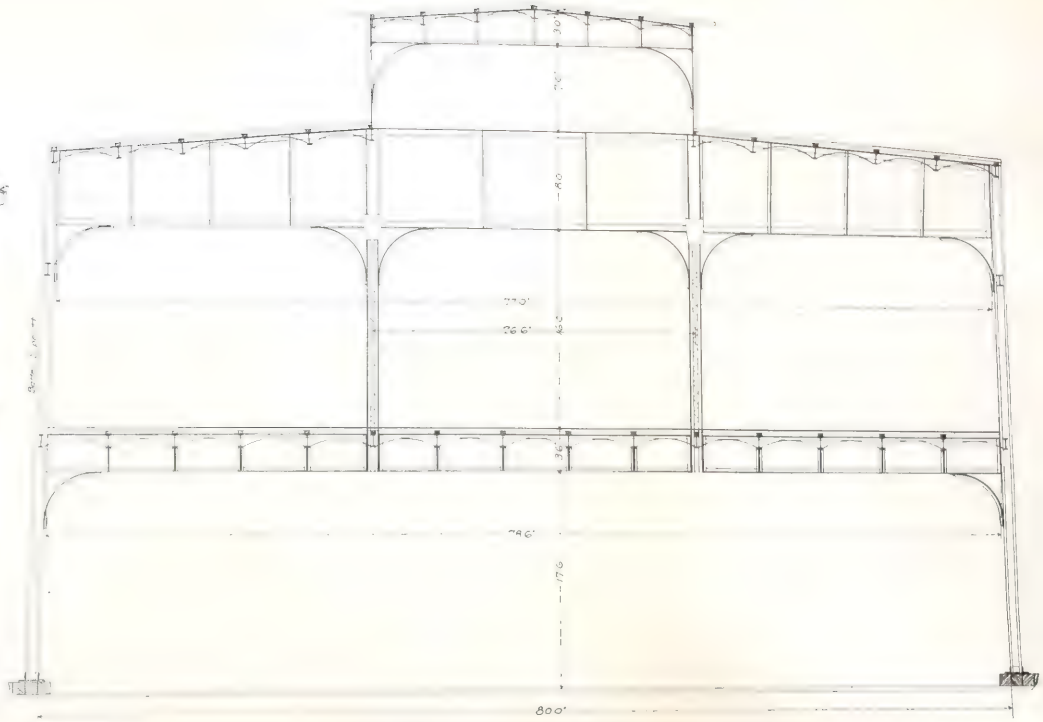
PLATE 11

1



PIER AT W. 59th ST.
NORTH RIVER.
NEW YORK.

SCALE.

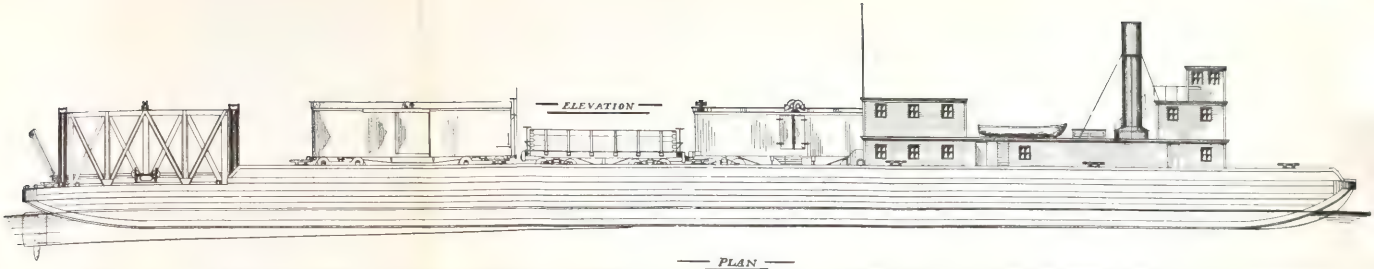


NORTH GERMAN LLOYD S.S. CO'S PIERS.
HOBOKEN, N.J.

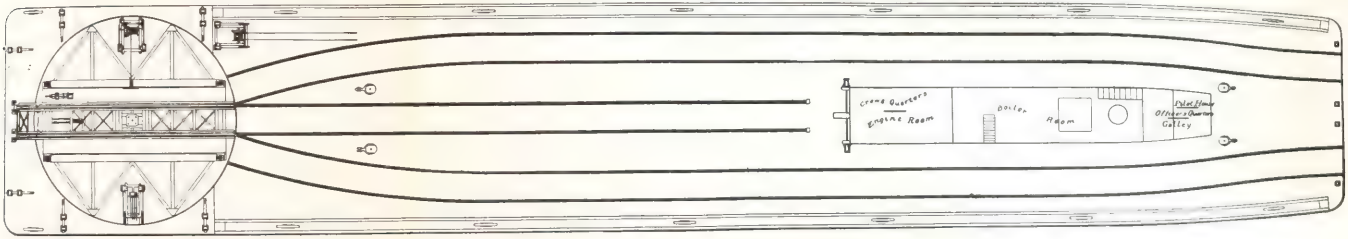
SCALE

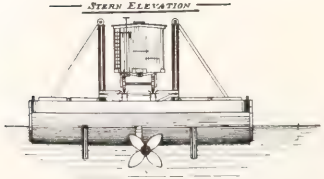
PLATE 12.

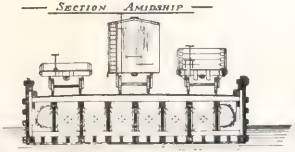
UNIVERSITY OF
URBANA

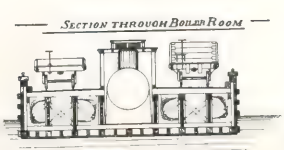


PLAN









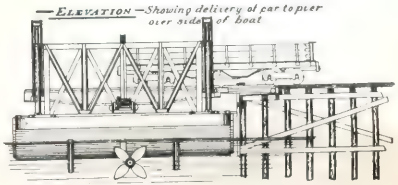


PLATE 13.

SPECIAL DELIVERY CAR TRANSFER STEAMER,

U. S. Patent No. 576941—Feb. 9, 1897

WALTER G. BERG, Patentee. 201 West 52d Street, New York, N. Y.

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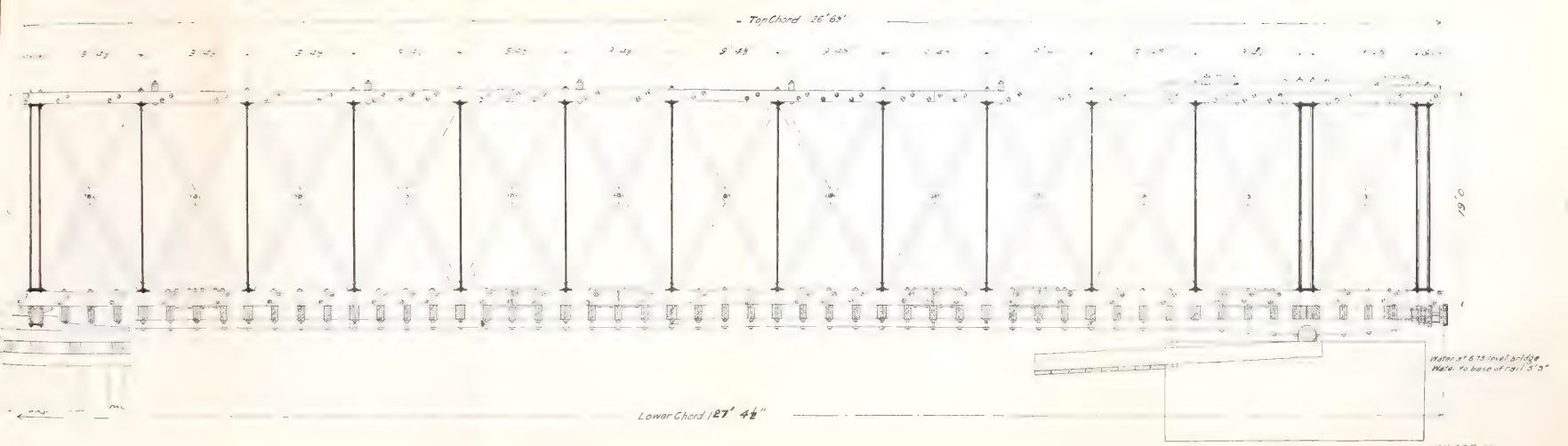
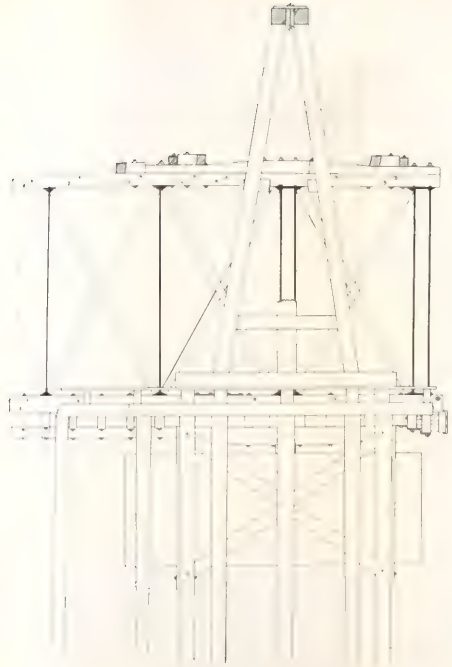

Top Chord 26'6"
19'0
Water at 6'3 level bridge
Water to base of rail 3'3"
Lower Chord 127' 4½"

PLATE 14

1



TRANSFER BRIDGE.

SCALE

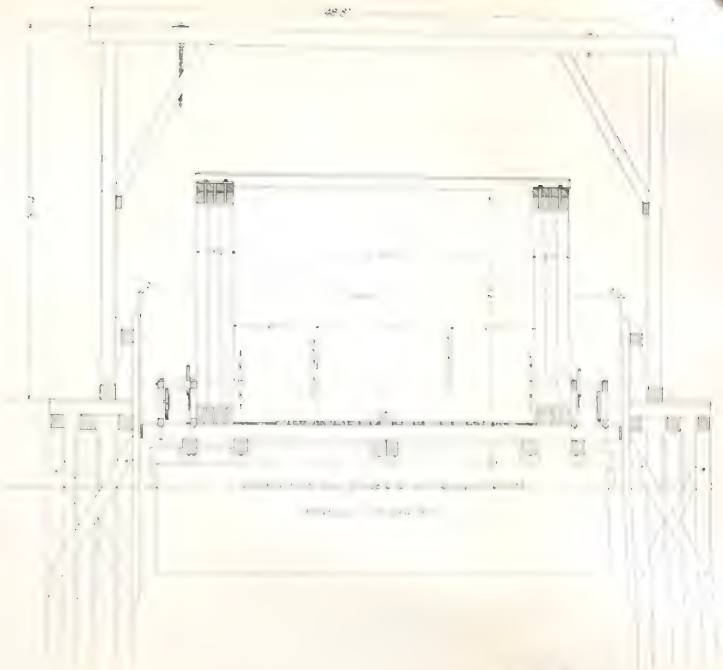


PLATE 13

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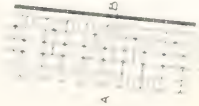
Portion of Boat n S.D.



TRANSFER BRIDGE

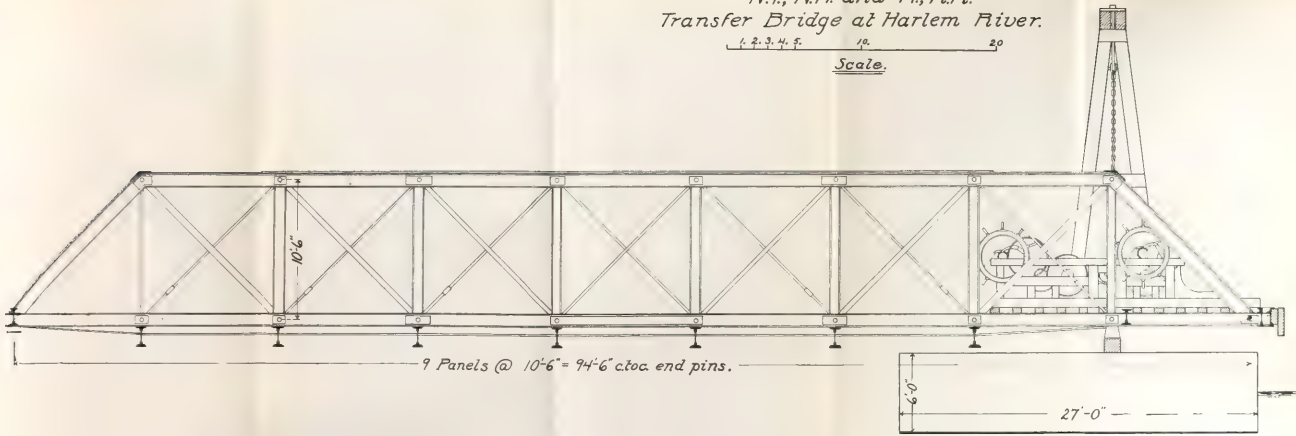
PLATE D

N.Y., N.H. and H., R.R.

Transfer Bridge at Harlem River.

1. 2. 3. 4. 5. 10. 20

Scale.



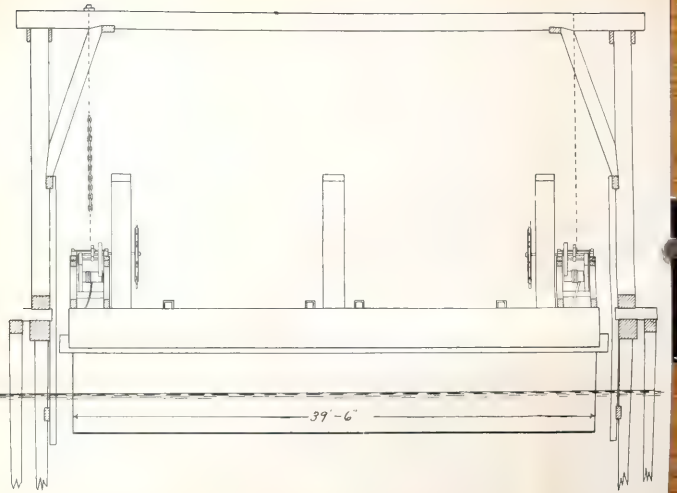
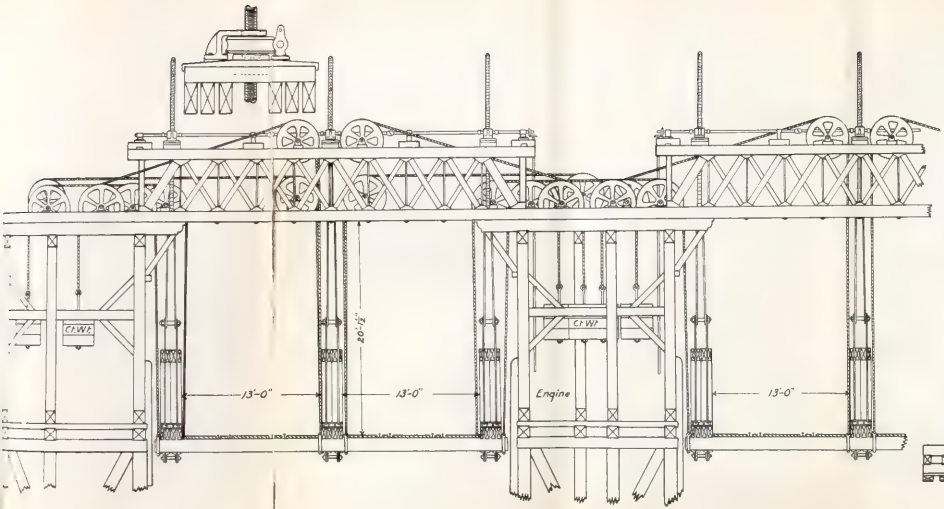


PLATE 17



Pennsylvania Railroad
Transfer Bridge at Jersey City.

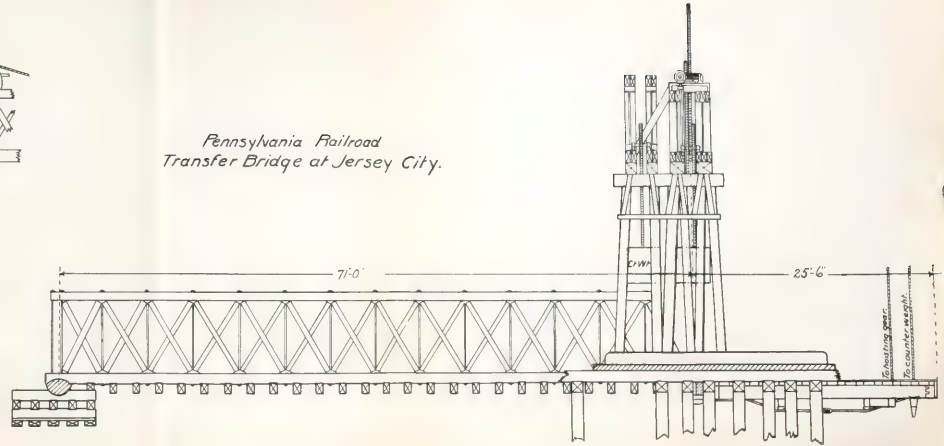


PLATE 18

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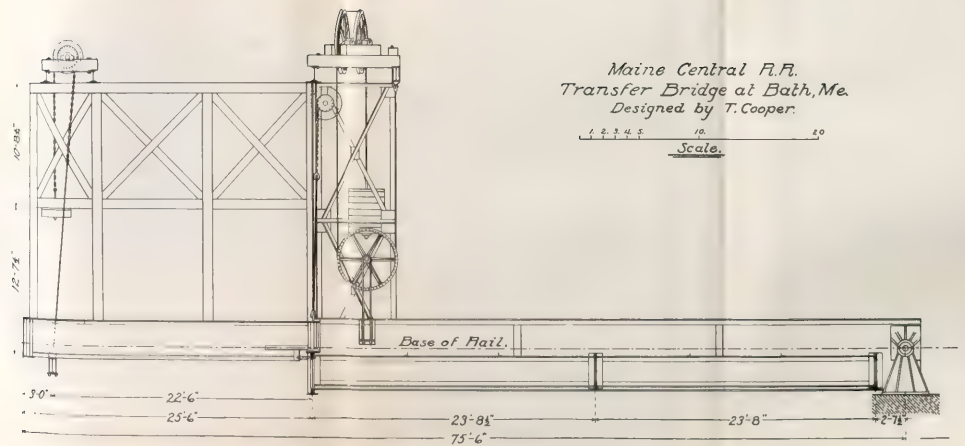


Maine Central R.R.
Transfer Bridge at Bath, Me.
Designed by T. Cooper.

1 2 3 4 5 10 20

Scale.

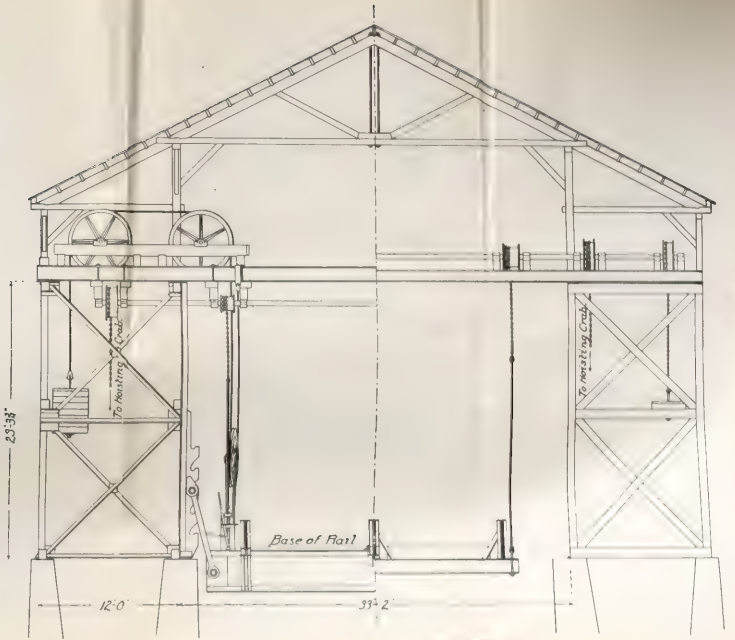


PLATE 19

The method of lightering freight to vessels named above has many advantages where wharfage is limited and rents are high. A floatload of loaded cars can be moored alongside a vessel so that one of the car's doors is opposite one of the vessel's ports. After this car is discharged the freight in the other cars can be wheeled through this one by way of the central platform. This work can be carried on while cargo is being discharged or received over the other side of the vessel upon the wharf. This practically doubles the wharf capacity, shortens the vessel's stay in dock, and allows bulk carloads to be brought to the vessel's side cheaply by an unobstructed water route instead of over expensive tracks through city streets.

A special delivery car transfer steamer is shown on Plate 13, patented by W. G. Berg, New York, designed to receive cars from an ordinary drop bridge and to distribute them to consignees located at various points about a harbor. The turntable at the stern allows cars to be landed either over the side or end of the boat, and is provided with hydraulic lifting power to enable cars to be landed at any stage of the tide. The cars are moved about on the boat and wharf by car-hauls operated by steam power. They are landed on the consignee's wharf and can be hauled to his yard, storehouse or factory to be unloaded.

Transfer bridges or drops for passing trains from the shore to the float are needed to overcome the difference of height, due to the range of tides and the change from loaded to unloaded float. These bridges vary greatly in design, but, speaking generally, there are two distinct classes, those having pontoon supports at their outer ends and those supported wholly by machinery without pontoons. These classes merge into each other, some bridges being supported jointly by pontoons and machinery. Another distinctive feature is the "apron," a movable platform between the bridge proper and the float designed to overcome small changes of height of the float while it is being loaded or unloaded. Aprons are used generally, but not always, on bridges without pontoons, and are not generally used on those with pontoons. Transfer bridges for wagon and foot travel, however, whether supported by pontoons or not, generally have small aprons.

Transfer bridges supported on pontoons will be first described. Plate 14 shows the side elevation of a Howe truss drop bridge with pontoon support. It is typical of the great majority of these structures in use at Boston and New York a decade ago. The shore end rests on a timber rocker supported on pilework. The ends of the lower chords abut against timbers running ashore over the sea wall to a cluster of piles. The rocker furnishes the hinge about which the bridge revolves as the height of tide changes. The heel sticks and bunter piles resist the shocks from the incoming floats. The pontoon is usually a rectangular closed tank, planked, caulked and generally coppered like the bottom of a ship. It should be made amply large to carry the unloaded bridge and its submergence regulated by putting in water or stone ballast. Generally a series of timbers are secured to the top of the pontoon parallel to the

length of the bridge and a cross timber secured to them, which, with proper timbers under the bridge, forms a rocker, so that the principal bearing on the pontoon comes on this timber. Sometimes, on the contrary, the pontoon and bridge are solidly fastened at several points. In the former case the outer end of the truss acts as a cantilever from the pontoon rocker to the end, while in the latter the truss is supported at its extreme end and for the width of the pontoon. The gallows frame over the outer end of the bridge, shown in side and front elevation on Plate 15 and in plan on Plate 16 is supported on pile work outside of and independent of the bridge. Its office is to furnish a support to a chain as shown, which is wound on a drum by a hand wheel through a train of gearing attached to a platform built out from the bridge, as shown on Plate 16. This mechanism is used to raise the bridge in case it should be too low for the float; this condition, however, rarely occurs, so that the principal use of the frame is to support the bridge in case repairs are needed on the pontoon. The machinery platforms are also provided with windlasses for hauling in the mooring chains. The gallows frame and hoisting chain should be strong enough to carry the bridge when unloaded without the pontoon. The chains are, of course, slacked when the bridge is in use for trains.

The end of the bridge floor is arranged to act as a buffer to soften the pounding of the float when it makes a landing. Spiral springs, rubber cushions and various other devices have been used, but they are generally soon destroyed. A spring formed of two timbers blocked apart and away from the bridge floor on the principle of a board seat in a farm wagon is probably as durable as anything, but it is difficult to arrange any efficient appliance because a firm support is needed close to the extreme end of the floor for the sockets of the coupling pins. Unless some kind of a spring buffer is provided the bridge structure and heel connection is liable to suffer.

Forged coupling or toggle pins 5 inches square and about 7 feet long are used to maintain the bridge and float in position so that the tracks will match while a shift is being made. There are generally two of these to each track just outside the rails. These pins slide in two sockets each on the bridge and enter corresponding sockets on the float. If the pontoon is adjusted to carry the bridge higher than the float the usual method of coupling is to run an engine or loaded car onto the bridge until one side is depressed, so that a pin can be inserted in place, then the train is hauled off and run out on the other track to depress that side till the other pins can be put in. When the operation of shifting cars has been completed and the float is ready to leave, the practice at some points is to haul the float off the pins, often bending them seriously. This method of coupling and uncoupling is barbarous. A much better and quicker way is to attach a jack to the end post of each truss and use them to bring the two decks to a level. All four pins can then be inserted at once, and when the shift is completed the jacks can be used to free the pins so they can be withdrawn without straining them. This

method is used by the Long Island and Lehigh Valley roads and perhaps others, but many roads practice the loaded car method. The jacks can be arranged to work either way, so as to raise or lower the bridge as may be needed.

The trusses may be high enough to admit of overhead bracing, or they may be pony trusses. Much difference of opinion exists as to the advisability of diagonal bracing overhead and in the floor. In some instances where bracing has been used trouble has been experienced.

The overhead members shown on Plates 14 and 15 are simply crossties at right angle to the trusses. One office of the gallows frame pilework is to support guide strips, shown on the end view of bridge Plate 15, against which chafing blocks attached to the trusses act if the bridge is thrust sideways by the float or by rough water. There need be only an inch or two clearance, so that these guides will prevent any destructive side motion, and hence there is no need of lateral bracing. Moreover, if a rigid system is built into the bridge, the side swash of the pontoon and the roll of the float are transmitted direct to the hinges at the heel with a leverage equal to the length of the bridge, while if no bracing is used and the floor beams are simply hung below the chords, as in the drawing, the structure is flexible enough to bear against the guide without straining the hinges.

Pile racks, as shown on Plate 16, are needed for guiding the floats into place and for holding them sideways while attached to the bridges. Their number and the make-up of their connections depends on the exposure of the water in which the transfer is located.

These bridges may be built wholly of iron or with iron trusses and wooden floor beams, or with timber trusses and floor like the one above described. Plate 17 shows a bridge at Harlem River, belonging to the New York, New Haven & Hartford Railroad, with pin-connected pony trusses and an iron floor system. At Fishkill-on-the-Hudson there is a plate girder transfer bridge 77 feet long belonging to the same railroad and operated exactly like the one described. The hinge is a pin through the girder 10 inches below the base of rail. Both of these iron bridges have 1-inch square lateral bracing.

In this class of bridges the pontoon performs the part of a counterweight. It has the advantage of adjusting itself automatically to suit the tides and the disadvantage of being seriously inconvenienced by ice in localities where ice occurs, and if in a silt-depositing locality redredging is expensive.

The Norfolk & Carolina Railroad described a transfer bridge located at Norfolk, Va., in Engineering News, Vol. XXVII, p. 96, consisting of a plate-girder span 101 feet long, having a pontoon rigidly fastened under the girders near their outer ends. It was furnished with a gallows frame of the ordinary pattern, and the pontoon had 10-inch sea valves for admitting water ballast and two 6-inch steam ejectors for expelling it. By these appliances the bridge could be lowered 6 inches per minute or raised 2 inches per minute. It was stated, however, that the usual method

of adjusting the bridge to the float was by means of loaded cars and the gallows frame, although it was very destructive to the coupling pins.

At Benicia, Cal., there is a drop bridge 100 feet long by 44½ feet wide, to serve the great 4-track ferry steamer Solano. It is provided with a pontoon rigidly fixed to the bridge but far enough below so as to be always submerged. This pontoon is adjusted to carry only a part of the bridge reaction, 25 tons being carried by two counterweights suspended in towers at each side of the outer end of the bridge. The bridge is kept high enough so that the end of the ferry boat will enter under it, and when made fast the counterweights are raised by hydraulic power, which allows the bridge to lower to a seat on the boat; it is latched in this position and the counterweights released, so that when the train shift is completed the bridge is ready to rise again out of the way when the latches are cast off. It is stated that the hydraulic power is furnished by the attendant pumping by hand between train shifts. This method is sometimes extended so as to do away with pontoons entirely, using counterweights only instead. In this case the weights are made somewhat too small to raise the bridge and power is applied in some manner to produce the required motion. This style of operation of course demands constant readjustment for the stage of the tide.

A peculiarity of all drop bridges of this class is that they are free to move up and down with the float; hence they are very liable to serious damage from careless handling of a heavy float, and on account of the rigid support at the shore end and the yielding support at the sea end they are subject to very severe strains from the wrenching which occurs when one side is loaded and the other not. The natural field of this class of bridge would seem to be for single track service only. When they are required to carry more than one track it is probable that their durability will be enhanced by omitting all lateral and transverse bracing. Like a logging sled, the more readily they adjust themselves to the roughness of their service the easier they will work and the longer they will last.

The Pennsylvania Railroad transfer bridge at Jersey City is a good type of the class which are supported wholly by machinery without pontoons. It is well described and illustrated in Engineering News, Vol. XXIII, p. 67, and the accompanying inset. An outline copy of the illustration is given on Plate 18. The plant consists of two independent double-track, three-truss bridges side by side, serving two ferry slips. The dead weight of the trusses at the outer end is nearly counterbalanced by numerous weights acting through wire ropes, as shown. The balance of dead weight and the train load is carried by long screws actuated by steam power. The apron is hinged to the trusses and its outer end carried by counterweights and hand-hoisting gear very similar to that described as used on the gallows frames of pontoon drop bridges. The apron is kept high when not in service, and when a float is moored in place the apron is lowered to a bearing on it and the hoisting lines slacked.

The bridge is kept approximately at a constant height above water by occasionally starting the engine. It is stated that this adjustment is

made about 12 inches at a time, this being close enough to the precise height required for all practical purposes. A floating gauge with graduated stem moving in guides fixed near the side of the bridge shows when the bridge should be raised or lowered. The office of the apron is to accommodate the changes of level of the float due to its loaded or unloaded condition. It moves freely up and down with the oscillations of the float and acts as a flexible connection between the float and bridge. Five-inch sliding coupling pins or toggles are used for holding the bridge and float in line; but as the apron is lowered upon the float evenly and the pins withdrawn and the apron raised before the float is pulled away, the pins are not subjected to such barbarous usage as in the case of pontoon bridges adjusted without jacks.

The engine is located in the framework between the two bridges and operates the worm shafts overhead which mesh with the large bronze metal nuts on the supporting screws as shown in detail.

The double rails on the bridge are for the purpose of matching differently spaced tracks on various floats.

This bridge can be operated much quicker than those supported on pontoons; the attendants adjust the bridge to the proper height between shifts, so that all there is to do after a float is moored till a train can be passed over is to drop the apron and fix the coupling pins in place, the work of about 30 seconds. The bridge is much less liable to damage than are those without aprons and consequently will last much longer. The whole outfit is roofed over and housed in excepting the ends. Altogether it appears to be the most scientific in design and convenient in operation of all those described in this paper.

Plate 19 shows the main features of an iron structure on a plan somewhat similar to that described above, except that no steam power is employed. It is located at Bath, Me., and is used for passing all trains of the Knox and Lincoln Branch of the Maine Central Railroad over the estuary of Kennebec River. The bridge is raised and lowered by hand windlasses working through a suitable train of gears. This support is designed to sustain the dead load only. The train loads are carried by a pair of eye-bars at each side of the bridge, the pins at the upper ends of which engage notches in plate iron racks attached to the main posts of the overhead structure. The notches are 22-inch pitch. The bridge must be raised or lowered one or more of these notches at any movement, hence the bridge cannot at all times be very closely adjusted to the proper height above water. The range of tide here is upwards of 11 feet. The bridge and apron are so short that at extremes of tide much difficulty is experienced in passing cars on and off the float.

Many styles of bridges are used for transferring cars from the shore to ferries not described in the above report, and appliances other than bridges are sometimes used for the purpose. At Hobbs Island and Guntersville, Ala., on the Tennessee River, there is a movable incline that accommodates a range of 40 feet between extremes of high and low water. Railroad Gazette of December 24, 1897, contains a schedule of

nearly all the car ferries in the country, and if members having charge of the landing stages of these ferries will tell us of their peculiar points, much of value will be added to this paper.

The President:—As all members have copies of the report, the chairman will open the discussion with such remarks as he cares to make upon the report of the Committee.

Mr. Onward Bates (Chicago, Milwaukee & St. Paul):—Gentlemen, here is a curious condition of affairs. As you all know, the modesty of civil engineers is proverbial, and the most modest of all are the bridge engineers. I am not the chairman of this Committee, but in the absence of the chairman I have been put forward by the other members of our modest Committee to present a report which I saw yesterday for the first time. You may all have noticed that the report contains a personal statement about me which could only be made by warm friends, who were particularly solicitous about my condition of health, and this leads me to a personal explanation. After I had as the original chairman appointed the sub-committees named on the first page of the report, I was compelled on account of ill health to withdraw from any active participation in the work of the Committee. My successor, Mr. McGonagle, who is now chairman of the Committee, is absent, and in presenting the report I wish to say that it is only a progress report. All members of the Committee have been busy, so busy they could not give the attention due to so important a subject, and even if they could have given unlimited time, a complete report could not have been made within twelve months. So that we offer only a progress report for your discussion, and as there are some things in it, like the specifications for bridges, which will require a great deal of study, I will be sorry to see the report approved and adopted at this meeting.

We have here sub-committee reports from Mr. Lum and Mr. Walker on trestles, Mr. Condron on specifications for structural steel, Mr. McGonagle on docks and wharves, and from Mr. Snow on piers and transfer facilities. I know that Mr. Douglas and Mr. Modjeski have done considerable work on the subject of metal bridges and trestles, including design and construction, and I hope to hear from them.

With this explanation the report is submitted for discussion.

The President:—This is an admirable report, and in order that the discussion may not scatter I would suggest that we divide the discussion up under the subheads as outlined for the sub-committees' reports. We will therefore take up first the report of the sub-committee on pile and frame trestles.

Pile and frame trestles on our American railways are a very important feature of our structures, and among roads in the Middle West and South they constitute a large percentage of the bridges. I have in mind a road in the Middle West, having a mileage of about 5,500 miles, on which there are 96 miles of wooden trestle bridges. The question of the future maintenance of the great number of trestles on all of the roads will in a short time be a serious one. There is one point which the Committee has failed to touch upon, and that is in regard to the method of replacing these long bridges or wooden trestles with some work of a permanent character that will not be unduly expensive. We have, for instance—particularly in the Central South—streams that are from 50 to 100 feet wide at ordinary stages, confined within bluff banks 15 or 20 feet high, with low, flat lands adjoining probably three-fourths of a mile in width, and these streams overflow but once or twice a season, but when the floods do come they are high. The bottom or flood lands are crossed by the long stretches of pile or timber trestles. To my mind, that is a very important question, and I would like information as to what we are eventually to do about replacing those trestles. We can not go on indefinitely renewing them in wood—timber is becoming scarcer and more expensive year by year—and it is quite a live question as to how we can economically and permanently deal with these bridges; whether to enlarge the waterways in the center and fill up the trestles and confine the streams, trusting that they will scour out a deeper channel, or use some form of steel trestle-work or short girders with concrete piers; and if we do fill up these structures and confine the channel, what the effect will be in regard to damages to landowners on account of floods. On the road with which I am connected we have had some serious cases of that kind. We have filled up a large number of trestles, and while I do not think we have materially changed the conditions, we have been subjected to very annoying and at times expensive suits for damages on account of our

changing the established régime. In regard to filling up trestles, I recall one very peculiar experience: My attention on one of my trips to the South was called to a crossing of a stream where the banks were low, with a trestle 2,000 feet long, which was rapidly filling up. There was a waterway under the bottom of the stringers of from 2 to 3 feet. The division officers recommended the extension of the trestle 1,000 feet. Increased length gave such a small amount of additional waterway, due to the filling up, that the difficulty was rather increased, and we therefore determined to reverse the process. A span was placed in the center of the trestle where there were some indications of a channel formation, filling a large part of the remainder, the result being that in the course of two years the flood line in that locality was so lowered that on a part of the territory which had not been under cultivation on account of water, cotton is now being raised. It would be interesting to the members of the Association to hear the experience and ideas of the representatives of the different roads as to what we shall do with these wooden trestles. Mr. Bates, your line has a very heavy mileage of timber trestles, has it not?

Mr. Bates:—I have been discouraged in stating the mileage of bridges owned by our company. Since my connection with the company we have reduced the mileage 44 miles of pile bridges, and we meet that question which has been referred to, that operating officials want as much bridge as there is width of water at high stage, while the engineers advocate the filling of pile bridges. Our experience has been that we have filled these 44 miles for about the same cost as to renew the bridges, because we have long stretches where the cost of an embankment is less per lineal foot than the cost of renewing the pile bridges. I may say further with reference to the reduction of waterways, that there have not been as many washouts due to such reductions as have occurred at old culverts of the original construction, so that the engineer's judgment in filling has been confirmed by experience.

The President:—Mr. Lum, you have had a good deal of experience in this matter on your road?

Mr. Lum:—I think our experience agrees very nearly with that of Mr. Bates and the President. We have a good many trestles and are filling them as rapidly as we can.

The President:—Have any of the members given serious thought to the replacing of these structures with some inexpensive form of open-work trestle, without the use of timber?

Mr. G. A. Mountain (Canada Atlantic):—Relative to trestles, I will say on a portion of our new road lately constructed we had about 15 miles of wooden trestles. In the course of the last six years we have filled about 14 miles, leaving a mile of wooden trestle. We have never made any attempt to replace them, although all these trestles are made of pine and we are in a country where that kind of timber is as cheap as any. When those trestles were put up timber was not worth more than $14 per 1,000 feet board measure. Today it is worth nearly double that amount. We find even at that price, in ordinary filling, where your pit is convenient for steam shovel work, that we fill the trestles just as cheap as we could replace a good many of them and we get a permanent roadbed. These trestles are anywhere from 10 to 30 or 35 feet high. We have some that were put up originally, double deckers, that were 50 and 55 feet high. These were replaced with steel. We have some 80 feet high, also steel. It was in a country where you had to build temporary work anyway, where you had to build wooden structures to get your steel there, as there was no means of transportation until the rails were laid.

I want to bring up a point in connection with these wooden structures, relative to the distance apart of the bents. We have been accustomed to put them 15 feet centers, and use a deck of 9 by 16 stringers; that would be six to a bent. Where you are running heavy engines, I think that is too far apart, and my idea would be, where wooden trestles are put up the bents should not be placed further than 12 feet centers. While the margin of safety is very large, still there are always defects in the timber and a certain amount of spring to them; and I would like to hear the opinion of members relative to distances apart of bents. It has been our general policy to make a permanent roadbed of steel structures.

The President:—I would ask the sub-committee with regard to the figures as given for the average yearly cost of maintenance, which run from 5 to 70 cents per lineal foot. It would seem to me that great difference between the minimum and maximum

amounts named is due to the fact that in some cases the simple maintenance of the existing structure was considered, while in others the average amount or the amount of its renewal has been averaged in year by year. On our line the cost is from 50 to 60 cents per foot, but that includes the cost of rebuilding the entire structure to the end of its life, and we average that period.

Mr. I. O. Walker (Nashville, Chattanooga & St. Louis):—The Committee is a little bit to blame for not getting this information in better shape. The question in circular 18 left it so that at first glance the gentlemen filling the report might assume that the cost would be the yearly cost against the bridge, including renewal and ordinary maintenance. For that reason we state that the information is hardly as complete as the Committee desired, but we hope to have it in better shape for the next report.

The President:—Another point that this Committee could well consider is what amount can a railroad afford to spend for a permanent structure to replace a temporary structure? Can it be limited to the capitalization of the amount that is needed to annually maintain those structures, or should an allowance be made for what we might call insurance, or for losses on account of disastrous accidents due to derailments—or can we afford to spend still greater amounts than this in order to have a permanent work?

Mr. Mountain:—Should you not take into consideration the liability of fire to wooden trestles? That is another item that ought to be taken into consideration in the maintenance of wooden trestles.

The President:—The question as to the loss by fire—that is, what it will cost to renew a structure in case it is burned down—can generally be determined in dollars and cents by the larger companies whose records cover a series of years, because it can be averaged. Of course, the matter of disastrous wrecks from fire is a very uncertain element.

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis):—The Committee in reporting on the question of covering stringers with galvanized iron, seems to have given special heed to the benefit to be derived from the protection of the timber from decay, and it might be well to call the attention of the members to the advantages of protection against fire also. In the ordinary trestle stringers there is always a considerable amount of sap-wood on

the corners that rots in advance of the rest of the stringer, and most fires begin at that particular point. Galvanized iron, if applied on top of the stringers, as long as it is sound between the ties, will protect the stringers against fires. The presence of the tie on top of the stringer causes the moisture to settle under the tie and causes the iron to rust out more quickly than when it is exposed; but as it only amounts to a cost of about 8 cents a square foot to re-cover the stringer with galvanized iron, and as such covering even under the ties will last about seven years, if properly put on and the stringer is free from excessive deflections, it would be very well in my judgment to use it as a protection against decay and fire. One gentleman asked about the span length. I will state that I had some experience with the use of red-cedar piles, which are, perhaps, not altogether used on many roads. We have cedar piling that I personally know has been in our road for 21 years, and have been told they were six years prior, making 27 years. Out of that number, which consists of some three or four miles of trestles, I have known of only one or two piles removed on account of decay, and as a result the question of filling trestles is only one of comparing the cost of renewing the braces and deck with that of filling. The sub-committee seems to have run against some snags in not being able to get reports from members as to cost of maintenance of trestle-work. This data is of course necessary before any recommendation can be made as to when trestles should be filled.

The President:—The average cost of trestle bridges from 10 to 15 feet high in the Mississippi Valley is about five to six dollars per lineal foot of track, that is, for the present standard. In the North, where there is an increased cost in the price of timber, the expense is greater, and this will also be increased in proportion to the height of the structure.

Mr. D. D. Carothers (Baltimore & Ohio Southwestern):—I want to make inquiry of some of the people who have used metal covering over the stringers, as to how much additional life they secured in the stringers. I notice the Committee refers to the life of the metal covering, but they do not say how much additional life they secured for the stringers. On one division we have had two standards, being two roads consolidated. On one we had spans of twelve and one-half feet centers of bents. On the other we

have fifteen. But I have just decided to reduce that, as the gentleman just remarked, that we find a good deal of deflection in the stringers. While they are of ample strength, it is impossible almost to secure a smooth riding track over long trestles and we have decided to reduce the length of our spans to 12½-feet centers. I think it would be an important matter for the Committee to consider.

The President:—With reference to the length of stringers—I believe the greater number of roads use a long stringer in order to break the joints. It takes over two spans. The increased cost of stringers 30 to 32 feet long over those 20 to 24 feet long is getting to be a serious matter, particularly owing to the dimensions of our standard stringers—8 or 9 by 16 inches.

Mr. A. S. Markley (Chicago & Eastern Illinois):—In our experience in the protection of bridges from catching fire, we found it was not practicable and did not pay. Trains passing over the bridge wear holes in the iron, as well as buckling up in places, and cost considerable to maintain and renew, and unless it is kept in good repair, it does not properly protect. It has also the further disadvantage that in case of fire it is very hard to get water to it on account of the iron preventing it. Once started under the iron it is very difficult to put out. In 32 years' experience in bridge work, there has never occurred a single accident to trains caused by bridge or trestle catching fire in any way whatever, and I am safe in saying, in that time $1,000 would pay all damage done to bridge or trestle by fire. I am quite sure that, had all the bridges and trestles been covered with iron over which I have had jurisdiction, the cost would far exceed the money saved. The cost of covering stringers is about 17c per foot of bridge, or $897.60 per mile of trestle for stringers only. Fire is almost always discovered by train crew or section men before any serious damage is done to the structure. While covering the timber does increase the life of timber where it is properly maintained, it is not sufficient to justify the expenditure in this section of the country.

Mr. Bates made the remark in regard to washouts in reference to the permanent structures. Fifteen or eighteen years ago if we did not have three or four washouts in time of high water we thought there was something wrong. In the last ten years

we have been continually renewing our trestles with permanent structures, and I am safe in saying in the past ten years I cannot call to mind that we have had a single washout. Of course in selecting places for putting in permanent structures the places that are the most dangerous and the trestles which are the longest are put in first, leaving the small ones for a future time.

The President:—If there is nothing further on this question of wooden trestles, the report of the sub-committee on specifications will be taken up. Mr. Condron, have you anything you would like to say?

Mr. T. L. Condron (Consulting Engineer):—The report itself, outside of the specifications offered for discussion, is very brief. Reference is made to data collected from specifications now in use, shown graphically on the accompanying diagram. By glancing at the diagram you will notice a wide divergence in the specifications of several railroads for the same class of material. The speaker is a member of another association, the International Association for Testing Materials, which association has been doing some work in the line of standard specifications and issued about 17 or 18 such specifications, covering all kinds of steel and iron. At a convention of that association, held in New York City, last fall, these several specifications were taken up and discussed, and the form in which they had been presented was somewhat modified by recommendations adopted at that meeting. Your Committee presents before this Association the original form of the proposed specifications for rolled steel of the International Association, with some modifications or suggestions that seem desirable for railroad practice. If this convention cares to discuss these specifications, it would seem desirable to follow the order in which the specifications are presented here, rather than without any order. The items are numbered and some of them are very brief and very usual. In the limits of tensile strength and other properties of the steel on tension tests, the changes that have been made and shown in bold type, were those most nearly in line with the specifications of a majority of the railroads that were considered. In addition to the 40 specifications shown on the diagram, the speaker also considered about as many more, he having collected a large number of specifications for consideration.

The President:—I presume there is no more important sub-committee report than that before us. The diagram in the report graphically shows the great disparity existing between the different roads with reference to specifications. On the extreme right of the diagram, the heavy black blocks, as I understand it, are the specifications recommended by the sub-committee. Is that correct, Mr. Condron?

Mr. Condron:—Yes, sir.

The President:—It seems to me that this is a subject which should be taken up in the immediate future, and on which we should get together and arrive at some recommendation as to uniform practice. Of course, the Association has not the power to require the roads represented by our members to adopt any of these specifications, but we can recommend them to the roads in the same manner as the American Society of Civil Engineers recommended the rail sections of its committee, which have since become the nearest approach to a uniform section we have in this country. While it might not be proper at this time to take decided action on it, it seems to me the proper course to take would be to have the Secretary call for letter ballots from the members as to their opinions of the specifications submitted, and as to their willingness to recommend them as standard to the roads with which they are connected.

Mr. Condron:—Anyone who has been in the mills much would find the difficulties I have stated in this report. If there were recognized standard specifications used, the manufacturers would know what they were, without having to study the specifications for each order. Material would be made to the specifications, and we would not have to fit the specifications to the materials. The point is, if specifications for bridge steel were uniform in requirements, there would be more uniformity in the steel delivered for railroad bridges.

Mr. Bates:—I wish to say something about this matter of specifications. It is of great importance that we should all agree on these specifications, and each one should be willing to waive something that he wants in order to obtain a uniform specification, because we will get the mill product in any case, and we should stand together and raise the standard of that product. I have recently looked into the subject of mill inspection with Mr.

Condron, who spent about two weeks at the rolling mills, and the one thing impressed on my mind is that we are getting what the rolling mills make. The specifications for our road are in some respects different from those of other roads, but we get exactly the same material. We wish to get a good commercial article. We do not want anything that is extra fine so long as we know what we are getting, because we can design bridges, and if we know what the material is good for we can make the right kind of a bridge. Now I have had trouble in getting open hearth steel. People who ought to consider their reputation told me that if I did not take Bessemer steel I should have to wait. I remember one case where I finally got it, the steel broke in punching and when it was analyzed there was every indication that it was Bessemer. I know of no railway company that uses Bessemer steel in its bridges, and yet when I recently called for bids on some work that was in a hurry I was told by two bridge companies that they could furnish the work if I took Bessemer steel, which they had in stock. Why they had it in stock is more than I can tell you.

I think we ought to agree on specifications for steel and suggest some scheme of letter ballot on these submitted by Mr. Condron. If we get the determination of the majority of our members and adopt such a specification officially it will come into universal practice, just as has been referred to by our President with regard to the American Society standard for rails.

The President:—Mr. Webster, we would like to hear from you as to your opinion and what you think of these specifications recommended by Mr. Condron.

Mr. Webster:—The specifications referred to by Mr. Condron are only proposed preliminary specifications. No one has been asked to use them, as we do not consider that they are in final shape. What is wanted, is a thorough discussion of them by this Association. The summary of the leading specifications for bridge material is given on this large table that I have here, and is much clearer than the small graphical table given by your Committee. It was prepared for easy reference, and might be printed to advantage with the present report. (See insert.)

One point in the specifications might be made a little more prominent, that is the clause on eye-bar material. The bending

test of the bar, as it comes from the rolls, will check brittleness, due to too high finishing temperature; if the test piece is annealed, the bend will not check this, and the full-sized bar may not be restored by annealing in the large furnaces. That is, material should be all right before the bars are up-set and heads forged. The manufacturers will give you good material if you insist on it.

One modification offered is .03 Phos. for rivets and .04 Phos. for plates. In giving this, the manufacturers will go much lower, and at times get the steel full of oxides of iron. This is often indicated by low manganese, as the amount of manganese added to the molten metal for an ordinary heat is, to a large extent, used up in heats of this kind by the oxides of iron, and goes off in slag. Where you have low phosphorus and very low manganese, look out for trouble. If you insist on having very low phosphorus, put a low limit on the manganese, as well as the high limit, for the reason given.

The bending test on soft steel reads: "For soft steel the specimens for bending tests shall have sheared edges from which the sharp fins may be dressed off with a file; but otherwise the edges must be left as they come from the shears. . . . . Soft steel shall bend cold round a diameter equal to the thickness of the specimen tested and have sheared edges."

This is too severe, and I do not think the Committee have carefully considered the matter. In shearing, the contact of the shear knife hardens and compresses the metal for some distance back from the sheared edge. If this hardened metal is brought to the outside of the curve in bending the piece, it cracks. Pieces sheared in the ordinary way have one edge compressed and the other rounded, and when bent the compressed edge will crack, and the round edge will show much better results. But if the piece is turned upside-down before the second cut is taken, the two compressed edges are then brought on the same side of the test piece, and if these compressed edges are kept to the inside of the curve in bending, the results will be very good. This is an old trick, and familiar to many of the gentlemen present. I do not think Mr. Condron was ever able to make a bending test of soft steel with sheared edges that met the requirements now specified.

Mr. Condron:—Something has been said about phosphorus. During the past two months over 3,000 tons of open-hearth steel

plates have passed under my inspection. There was not a single analysis that ran above .04 in phosphorus, and I should say there was probably not one per cent of the many analyses submitted that ran over .03. Mr. Webster has referred to the bend test spoken of, and I admit that the bend test recommended is a radical departure from the usual one, but soft steel is supposed to be used with sheared edges, and punched holes, while for medium steel it is usual to plane the edges and ream the holes. If the soft steel is to be used, without having the holes reamed or edges planed, then the material should be of a quality which would stand severe punishment in that shape. It may be the limit is set a little small, as to the diameter around which it should bend, but I am convinced that a bend test of soft steel with sheared edges is a desirable thing. In this connection on a lot of material we have recently handled, a bend test was required on every plate. A great many, I might say thousands of bend tests, were necessary in connection with this order, and these tests were made on specimens with sheared edges. They were what are called quench bends, that is, the specimens were first heated to a cherry-red and then quenched in water before being bent. This quenching, contrary to common belief, does not temper low carbon steel, but really anneals it.

Mr. Webster:—I do not question the ability of our manufacturers to keep the phosphorus below .03 or .04 in basic open-hearth steel, but what I called attention to was the danger of their going lower than this, and getting steel full of the oxides of iron. This matter was fully discussed when we decided on the higher limits for phosphorus.

I agree with Mr. Condron in that it is a good thing to make bending tests on soft steel with sheared edges, in order to know how much it has been injured by this treatment, as it is put in service in this shape; but what I do decidedly object to is his calling for a bend of 180 degrees over its own diameter on any plate, angle or other shape, with sheared edges, when experience shows that the test is much too severe. I would like to ask Mr. Condron a plain question: "Have you ever been able to get the bend you ask for, of soft steel with sheared edges, without turning the plate over in shearing and heating and quenching it in water, which anneals the edges, where the metal was hardened by compression or shearing?"

Mr. Condron:—I have seen bend tests of this character made that fulfilled the conditions required here. I am not prepared to say how they were sheared. It is possible they were sheared as you suggest.

Mr. Webster:—If the specification is properly prepared, all conditions should be stated, and you can protect yourself. That is the point I call attention to.

The President:—What do you think about the propriety of this Association taking action on these specifications?

Mr. Webster:—As chairman of Committee No. 1 of the American Section of the International Association for Testing Materials, I can assure you that we would be very glad to have this Association take up these bridge specifications and give us your views of them. If your Committee desires to take up each of these points with us, we would be pleased to meet with them, and endeavor to decide each point on its merits. This course would certainly give more weight to the specifications.

President Wallace:—I would like to ask the Committee if they are a unit on these specifications? Mr. Modjeski, what is your opinion?

Mr. Ralph Modjeski (Consulting Engineer):—There is a question in my mind about the advisability of adopting any standard specifications. To adopt a standard specification and say, "This steel is good enough for us," would have a tendency to retard the progress in the manufacture of steel. If we had adopted a standard specification fifteen years ago, we would probably still be using Bessemer steel for our bridges, and if you take the specifications that were issued during the last fifteen years by different engineers who study the question, you will see a marked advancement from year to year. For instance, most of our specifications for bridge steel call for furnace-heat tests at the mill. I have recently been informed that certain mills are about to refuse the furnishing of such tests. Now, then, the engineer has to modify his specification and require other tests which will assure him of the quality of his material in another manner. I don't know but we may be using nickel steel for bridges within the next few years, so that I am of the opinion that any standard specifications are undesirable.

The President:—What is your opinion of these specifications, Mr. Modjeski?

Mr. Modjeski:—I have not had time to look over them thoroughly. Certainly they are good on most points, and I would indorse them for the present; but I would not indorse—nor recommend—them as a standard to serve for some time to come.

The President:—There is one point which should be clearly brought out and understood by the members, and that is, if we adopt a standard now it is not to be considered ultimate—that it is only a step forward, looking to uniform practice. In that light we can afford to adopt a specification, and can change it when necessary. In this connection we might change the word "standard" to "uniform"—a uniform specification as near as we can get it. It should not be understood that if we adopt it that it is to be permanent and that we are tied down to it. The only question in my mind is as to the proper way to pass on the specifications of this kind. A majority of the members here today are not bridge engineers. I presume there are gentlemen in this hall who are competent to judge of this matter and whose opinions are valuable, and it seems to me that if we are to make an attempt to adopt specifications, we should do so by letter ballot, in order to give our members time to consider them and to consult with the bridge engineers on the roads with which they are connected, and in this way we will come to an intelligent decision.

There is one point which is not entirely clear to me from Mr. Webster's remarks, and that is with reference to character and extent of the Committee to which he referred, and with which he is connected.

Mr. Webster:—It is the International Association for Testing Materials.

The President:—How is it formed?

Mr. Webster:—It has a membership of about 3,000. It started in Germany some years ago. I don't want to take up the time of the meeting to give its history. I am a member of the sub-committee in this country on specifications.

The President:—How would it interfere with the work of this Association if we should adopt a standard of this kind, with the understanding that when there is something better comes up we will adopt that?

Mr. Webster:—That is exactly the position we take. We are willing to change it. I spoke of it that way.

The President:—The main question is this: What is the element that controls that Association? Is it the manufacturers of steel or the engineers or the scientific men?

Mr. Webster:—Originally the scientific men entirely. A few years ago they decided to take up international specifications, and then the manufacturers became very much interested. Committee No. 1 of the American Section was composed of two members, Mr. James Christie and myself. We saw that two men could do nothing with the mass of work before us, increased the Committee to five, and from time to time have increased our membership to 34, about evenly divided between engineers and manufacturers. Our work being based on the existing specifications, we first collected the specifications in this country, and divided the Committee into ten sub-committees, each working on a separate class of material. The specifications prepared are only proposed preliminary specifications (as I have previously stated) put in shape for discussion. These proposed specifications were printed, widely distributed, and were the subject of general discussion at the annual meeting of the American Section, last October. There has been no attempt to put these specifications in use, we do not consider them in final shape, and will make whatever modifications necessary.

It is hardly necessary to say that a great deal of work had to be done to put things in their present shape. Most of the engineers were too busy to devote much time to the preparations of the tables, etc. The manufacturers did the greater part of it, and I think we are all indebted to them for their trouble, and the thorough manner in which the work was done.

The President:—It would seem to me that the proper way to get action between the two committees would be simply for our Committee on Bridges to keep in touch with your committee in an informal way.

Mr. Webster:—That would be very satisfactory.

Mr. Condron:—I want to take exception to the idea of intimate relationship between the two associations. I consider uniformity of action between the two is not necessary. The two associations stand in different positions, and need not be embarrassed by each other.

Mr. Webster:—I don't think there is any desire whatever, on the part of the American Section of the International Association, to have any American society connected with the International Association. What we want is to have a fair representation of American ideas, and it makes no difference whether we get them here, or from the American Society of Civil Engineers. We want a fair representation of the views of the American engineers on this subject, and if you get up a specification that is a fair representation, I think we would like to adopt it; and if, on the other hand, you put in some requirements which are not fair representations, we would like to meet you, and talk it over, and see if we cannot harmonize our views. I do not think there should be any connection further than that.

The President:—As I understand it there are three elements —the manufacturers, who produce the materials at the lowest possible cost per ton; they are combining, of course, in order to get economical results. Second, the consulting engineers and engineers who look at this question from a scientific standpoint, who desire to obtain a scientifically perfect product. These men may be independent consulting engineers, or testing engineers, or bridge engineers employed by the various railroads. Third, the users, the buyers of these products, to whom it is immaterial what the technical chemical constitution of the material may be, but who do want their bridges made so as to give the maximum amount of strength and last the longest possible period of time for the least expense.

Now, the primary question is, how are we going to get these elements together. The first thing we want is the specifications, and the next thing is to enforce the specifications. Owing to the combinations of manufacturing interests, they are in a position to practically force their product on the engineer and on the user, and it would seem that the time is approaching when it is necessary for the engineers to stand between the manufacturer and the user and to say, through their organizations, what the specifications should be and endeavor to see that the buyer obtains that product.

Nothing can be accomplished upon a simply scientific specification, without regard to the other elements. Given the very best scientific specification that can be devised, if it is not practical for

the manufacturer to produce the material in large quantities and produce it at a profit—if it does not represent at least a large average quality of his product—it will not matter how scientifically perfect our specifications are—the specifications will be ignored by the manufacturer.

In regard to the enforcement of specifications, while the manufacturers may be able to ignore the specifications of one engineer—if the engineers as a body adopt specifications and seal them with the stamp of their approval as being recognized by engineers and approved by the users, there is more probability of getting a good product than if we did not adopt specifications on which we can set the seal of our approval.

The only question now, it seems to me, is whether this Association at this time desires to take any further action in regard to the approval of the specifications, and if it is not desired to express an opinion on them now, what would be the best way in which to arrive at a conclusion?

Mr. C. S. Churchill (Norfolk & Western) :—Speaking about changes in standards, I think we have all been through the same course, namely, during periods of from two to five years we have changed specifications for materials used on railroads and in structures of all kinds. I see no reason, therefore, why a standard specification should not be adopted, with the idea, as suggested here, that it be changed in case of any improvement. I have not had any trouble in getting our specifications lived up to. I think it is because we have not tried to keep the one specification over too long a period of years. My last bridge specification was made in 1899 and a number of improvements were incorporated at that time. I see no reason why a specification recommended by this body should not be changed in the course of two or three years, and it is my understanding that this is the whole idea of the Association for Testing Materials, of which I am a member. The idea is that it shall present the best practice at this date, and to carry that idea out, it seems to me a letter ballot should be arranged for by the Committee, from every member of this Association. The results of the ballot should be given to Mr. Webster, as representing the opinions of our members. This would help him in giving additional weight to his compilations and the results he would officially present before the International Society. I

think that should be the course for us to follow and I would heartily recommend a ballot of that kind.

Mr. Modjeski:—I judge any change suggested at any time after the specifications are adopted would take a long time before it could be changed. It would be more difficult to introduce changes in practice than if we did not adopt the specifications. Suppose an engineer in his experience found some point in the specifications which it was desirable to change, what process would be necessary to change these uniform specifications? It would have to go to Committee No. 1 and to this Association and probably to the International Association before it could be changed, and that would consume a great deal of time.

Mr. B. Douglas (Michigan Central):—I, to some extent, agree with Mr. Modjeski in thinking that specifications which are difficult to change are not advisable. I understand, however, that is not what is desired. If some specification can be adopted by this Association with some adequate means for changing it, it will be a good thing, but it should be clearly understood how that change is to be made, and we should know that it could be made readily. In my opinion, a fixed specification which is not changed in the course of a very few years, would be an undesirable thing.

The President:—I believe there is nothing in our plan of organization that would prevent specifications from being changed at any meeting of the Association. The Committee could recommend changes at any time. The Committee is a permanent one, and if the Association should adopt uniform specifications, as recommended by the Committee, there would be nothing to hinder their being changed whenever the Committee deemed a change desirable.

Mr. Condron:—The suggestion to eliminate the word "standard" is good. The word "standard" is not what is meant or what we want. "Uniform" or "typical," either one of these two words seems to cover the case more fully and accurately.

The President:—One point has not been touched upon as fully as the members perhaps would desire, and that is as to the real merits of the specifications as recommended, and also as to whether they are Mr. Condron's views or the views of the entire Committee, and if not, why not.

Mr. Condron:—As stated in the report, the Committee was unable to hold a meeting. Chairman McGonagle requested me to put the material gathered into shape to be used as a foundation to start further committee-work on.

The President:—That is exactly what the Association desires to know.

Mr. Condron:—The reason the Secretary attached my name to the report was to relieve the Committee from any embarrassment. The report is submitted solely as a basis for criticism and discussion.

Mr. J. P. Snow (Bridge Engineer Boston & Maine, by letter):—I appreciate the weight of what is said in the report on specifications for structural materials on the uselessness of attempting to procure small lots of material, covering possibly a large range of sizes under a specification differing materially from the manufacturers' standard. On the other hand, a standard specification unanimously adopted as final by our Association might tend to retard improvement in quality and composition of material by furnishing a club for strong manufacturers to use on a designer who should seek to demand something in advance of the established standard. It might easily get to mean more than was originally intended and become a drag rather than a help to progressive designers. American progress in manufacturing has been accelerated by the fact that our designers are not bound by precedent; in fact, they seek rather to produce something new—something different from their last design. A clear-cut perception of the end to be attained, with a full knowledge of the obstacles in the path is much better equipment for a designer than Draconic rules and moss-grown examples of what has been done.

We must, however, face the fact that our material is to be furnished by mills not subject to competition such as has existed in the past. Like the Standard Oil, they will discourage improvements that involve heavy expenditure even if the improvements tend to cheapen production or improve the product.

An agreement among all consumers on a reasonable demand will surely be met by manufacturers; our only strength lies in such an agreement. So far a standard specification adopted by the Association is valuable. It should, however, be progressive, not final. It should be open to revision each year, and the Com-

mittee should, I think, report progress only; examining each year what is new in this country and abroad in the line of improved material, either proposed or accomplished; and report such as seems worthy of assimilation in our adopted specification. In short, they should give us the history of the world in this particular for each twelve months ending with our annual meetings.

As to the requirements recommended by Mr. Condron: Although they differ somewhat from those that I have been using I would gladly adopt them for the sake of union, except his specification for rivet steel. I am sure this is too high; 48,000 to 56,000 is high enough for machine-driven rivets, and steel below 52,000 should be used for those driven by hand. The proposed bending test for rivet steel is not severe enough. It is a very poor steel rivet rod, indeed, that will not bend 180 degrees flat upon itself. Stock for hand driving should bend flat successfully when slightly nicked. If we could be sure that rivets would not be overheated we could use harder steel, but in hand driving the men will burn the rivets in attempting to soften them. At best, steel is hard and difficult to use in hand work. We ought, I think, to get the softest obtainable, which not only drives easier but is less liable to injury by high heat than the harder grades. I have seen many scores of rivets, furnished and driven by one of our best bridge builders, break at the head opposite to the one being cut off after only two or three blows had been struck. These rivets generally showed the effect of overheating. Chemically they were all right except that the carbon was too high. I could not test the tensile strength of these rivets, but should judge from the composition reported by the chemist that it would be nearly 60,000 pounds. I very much prefer iron rivets for hand driving. We use Burden's exclusively for repair work, but bridge manufacturers complain so bitterly of buying the few required for field work that we feel compelled to allow them to use steel.

I hope most heartily that the Association will see fit to adopt a lower limit for rivet steel than that proposed by the report.

Mr. C. A. Wilson (Cincinnati, Hamilton & Dayton):—I move that the specifications of the sub-committee be referred back to the General Committee for further report at the next meeting, to give the members a chance to go over the specifications in detail before indorsing them.

The President:—That would mean another year's delay. I would suggest, Mr. Wilson, that you amend your motion to the effect that the Committee endeavor to secure an expression of opinion from individual members of the Association, so they can submit this with their next report.

Mr. Wilson:—I accept the amendment.

The President:—It is moved and seconded that the report of the sub-committee on specifications be referred back to the General Committee on Bridges and Trestles for further consideration, with the suggestion that the Committee correspond with the members through the Secretary of the Association to secure their opinion as to the advisability of their adoption.

(Whereupon the motion was put to the Association.)

The President:—It is carried. We will next take up the report of the sub-committee on docks and wharves.

Mr. Bates:—The special report on this subject is by Mr. McGonagle and Mr. Snow. I do not think there is anyone in this country better able than Mr. McGonagle to write an article on ore docks. I had occasion to build an ore dock last summer, and obtained from him information that enabled me to do the work properly. I recommend this report and Mr. Snow's as good reading.

The President:—Do the members desire to discuss the sub-committee's report on docks and wharves? The report seems to cover the question rather fully.

Mr. W. B. Hanlon (Cleveland, Lorain & Wheeling):—The report deals particularly with docks receiving ore for shipment on the lake. Nothing is said about the docks for receiving the ore after it is taken out of the vessel.

At Lorain, we handle about one-ninth of the output of what is shown on the diagram from our dock, and a great deal of that is stored back of the dock. In building a dock we have to provide for the pressure of the ore shoving the dock out. Up to the time we commenced dredging below 18 feet, we had an ordinary pile dock, but in our present location the shale is 18 feet under water and we have to dredge 19 or 20 feet. In one instance we came very near undermining the dock front. In 1899 we built 640 lineal feet of dock by using 8-inch iron gas pipe. We made a test along the dock front as to the depth of the shale by drilling, and

fixed 10 feet in the shale as the minimum depth of the pipe to go in the shale, and placed the pipe 8 feet center; the pipe being 36 feet long. To that line of pipe the wooden walling is fastened, the top anchored back. The strength of the front and piling alongside is close enough together to provide for the weight of material against the dock, including the weight of an engine. We built 640 feet of that style of dock in 1899, and last year we built 540 feet additional, using 10-inch I-beams in place of the 8-inch pipe. The pipe cost about $30 a lineal foot, as against $50 a lineal foot for a timber crib dock, which the government built adjoining our dock. Our dock has been in use almost two seasons, and stands very straight and in good line. The dock built with I-beams has not been tested, having only just been completed. The cost of the latter will not exceed $30 per lineal foot. We laid the gas pipe in the shale by drilling 10-inch holes for the 8-inch pipe; the minimum depth is 10 feet in shale, and that runs up to 14 feet, owing to irregularities at the bottom of the river. The 10-inch I-beam requires a hole about 13 inches in diameter; the cost of drilling holes and setting the pipe was $24.50 per hole; drilling the holes for the I-beams and setting them, filling them with concrete to the top of shale, $30 a hole.

The President:—In this connection I desire to call the attention of the members to a peculiar form of wharf construction which may be found at points along the Mississippi and Ohio Rivers, where inclines are used for placing cars on boats or barges for transfer purposes, and from which the loads are again transferred from the barges to the cars. This practice originated because shippers desired to load cars at points where railroad car ferries existed, in order to connect the river traffic with the railroad traffic, and the first step taken was the placing of cars on inclined tracks close to the surface of the water, and transferring the lumber, piling, etc., from the boats or barges to the cars. The business at some of these points has now become so heavy that the spaces for three or four cars was found to be inadequate to handle the traffic. At a number of points on the Ohio and Mississippi Rivers—one at Brooklyn, Ill.—a series of transfer tracks have been constructed at different elevations, five feet apart, the tracks being level for quite a distance; after they leave the inclined tracks, the entire train of cars can be placed close to the surface of the

water in order to facilitate the transfer of the commodity, different tracks being used, depending upon the stage of the water. I think it would be of interest to the members to have their attention called to this peculiar type of float—I do not know whether or not it would be proper to designate it as a wharf, but there are several places along the lower rivers where transfer wharves of this kind are being used. One of the difficulties with which the engineers of companies operating car ferries on the lower Mississippi River have to deal is the rise and fall of the river, and also the changing of the bars, the cutting-in of banks, etc. The Illinois Central Railroad has a transfer at Helena, Ark., one at Gray's Point, one at Cape Girardeau, one at Brooklyn, Ill., and another at Evansville, and at some of these points, particularly at Helena, it has been necessary to construct two and sometimes three different inclines—one for use during the low-water stage, another for the intermediate stage, and still another for use in extreme high water. On account of the changes in the channel, the cutting of the banks or the cutting of the bars, it was found necessary to periodically change the location of these inclines.

Mr. A. S. Markley (Chicago & Eastern Illinois) :—We have a system for transferring timber, etc., from barges at Joppa, Ill. The form of incline has been described by the President, but in addition to that we have double track barges, three holding 10 cars each, and one holding 20 cars. These barges are towed out into the river and anchored alongside of loaded barges and the cars are loaded from them. In this manner the incline is almost entirely kept clear. The cars can be loaded without being interrupted by switching or otherwise.

The President:—As our time is limited this morning and we have other important reports, we will excuse the Committee, and call for the report of the Committee on Rail.

REPORT OF THE COMMITTEE ON RAIL.

To the Members of the American Railway Engineering and Maintenance-of-Way Association:

We submit the following report:

SPECIFICATIONS.

We are not ready to submit a specification. Some changes in the process of manufacture have developed within the past year, which, if successful, will necessarily modify the specifications in use.

SECTIONS.

We find that the A.S.C.E. sections are in use on about 84 railroads out of 128 reporting, as follows: Fifteen roads use 60-pound; seven, 65-pound; twenty-six, 70-pound; twenty, 75-pound; twenty-six, 80-pound; twelve, 85-pound; five, 90-pound, and six, 100-pound sections.

It would appear from the present practice and the future outlook that there are more sections provided for use than necessary. Very few roads are using the 65-pound rail, and in a canvass of the future needs, only five roads thought they would need to use this rail in the future. In regard to the 95-pound rails, there are no roads using it, and there are no roads which seem to think it required.

For future requirements one road would use 56-pound; seventeen, 60-pound; five, 65-pound; twenty-seven, 70-pound; thirteen, 75-pound; fifty-eight, 80-pound; ten, 85-pound; ten, 90-pound, and twelve, 100-pound.

In regard to sections other than the A.S.C.E., there are thirty-six weights given, as follows: Two, 50-pound; one, 51-pound; two, 52-pound; one, 54-pound; nineteen, 56-pound; one, 57-pound; one, 58-pound; twelve, 60-pound; three, 66-pound; one, 67-pound; one, 69-pound; seven, 70-pound; two, 72-pound; eleven, 75-pound; one, 76-pound; nine, 80-pound; three, 85-pound; one, 90-pound; one, 95-pound, and two, 100-pound.

Some consideration of the above figures would indicate that five different weights of rail ought to cover the general requirements of all the railroads, as follows: **60, 70, 80, 90 and 100 pounds.**

We have collected the maximum axle loads in use for passenger engines, freight engines and cars, with the following result:

There are no roads where axle loads under 20,000 pounds are in use; seven roads have axle loads from 20,000 to 25,000 pounds; eleven, 25,000 to 30,000 pounds; twenty-three, 30,000 to 35,000 pounds; twenty-three, 35,000 to 40,000 pounds; thirty-eight, 40,000 to 45,000 pounds; fourteen, 45,000 to 50,000 pounds; four, 50,000 to 55,000 pounds; and none over 55,000 pounds.

A study of these figures would indicate that for the present and for the future there will be very few roads requiring the light rail, and a very large number of roads will require 80 or 90 pound rail.

The A.S.C.E. sections are giving general satisfaction. There are a number of roads not using the sections, stating that they have no particular objection to them, but do not wish to change on account of having so much rail of other sections.

Some roads report that their sections are so close to the A.S.C.E. sections that they do not think it worth while to change.

Your members have no doubt read in the technical papers of the recent development in rolling rails at a lower temperature.

Some difficulties have been developed with the A.S.C.E. sections on account of this change of finishing temperature of rails, which indicates that the flange will probably have to be increased.

We feel some hesitancy in suggesting new sections, but if all rails hereafter are to be rolled at a lower temperature, we think the section should be modified, and that the sooner the change is made the better for all concerned. This matter has been developed so recently that we are not prepared to submit new sections. However, the A.S.C.E. sections are not the only ones that will have to be modified on account of this change in finishing temperature, but other sections will have to be modified in the same way; that is, by providing additional metal in the flange.

It will be noted from the statistics appended, that about 90 per cent. of the railroad mileage is either straight tracks or with curves less than 2 degrees, leaving less than 10 per cent. of the track where there might be extra flange wear on account of curves.

We, therefore, do not consider it necessary to do any work in the way of suggesting special sections for the special conditions that might arise on 10 per cent. of our track, but it should be our aim to conform our standards to what will suit the other 90 per cent.

LENGTH OF RAIL.

The economical transportation of rails is governed by the length of the cars in which the rail is hauled. A great many of us can remember when 28 feet was the standard length of rail, which was fixed because this was the greatest length that could be carried on a single car. Later the cars were lengthened, so that 30-foot rails could be hauled; then 30 feet was made the standard length. During the past few years the length of the cars has increased, and there are now many cars 34 feet clear inside length, with many more of a greater length.

We think you should now take a step forward and make the minimum standard length 33 feet. This length should not cost any more per ton than 30-foot rails, and it has the great advantage of reducing the number of joints in the track 10 per cent.

We find that a number of roads have made 33 feet the standard length, and the mileage represented by the roads having this standard length is about 14,000 miles, about 10 per cent. of the mileage represented in your Association.

THE PROPER EXPANSION FOR LAYING RAILS.

We submit below a table showing the proper allowance to make for expansion for 33-foot rails.

The temperature shall be taken on the rail, and the openings between the rails shall be as follows:

Temperature: (Fahrenheit)	Amount of Opening:
20° to 0°	$\frac{5}{16}''$
0° to 25°	$\frac{1}{4}''$
25° to 50°	$\frac{3}{16}''$
50° to 75°	$\frac{1}{8}''$
75° to 100°	$\frac{1}{16}''$

Over 100 degree, rail to be laid close without bumping.

.s, state what	Which of the following v
.....	70-lb. would answer;
.....	70 and 80-lb., depend
	80-lb.
.....	85-lb.
., and I think ht also say for	70-lb. with a rigid joi
	70 and 80-lb.
.....	80-lb.
90-lb. have only	80-lb.
ning; all other it will last, on	At present think 80-l
.....	
	We have adopted 80-
	80-lb.
.....	80-lb.
	70, 75 and 100-lb.
	80-lb.
	70, 80 or 90-lb.
.....	90-lb. on main line.
.....	65-lb.
.....	90-lb.
sults from ASCE	We think 85-lt
	70-lb.
	80-lb.
.....	
d us to draw any	75-lb.
ghter grades, the	80 and 90-lb.
ttributed to dif- olled some years cently.	70, 80, 90-lb.
67-lb. and 70-lb.	70-lb.
s of the opinion anufacture.	80-lb.
.....	Our best wearin wearing badly, a
.....	100-lb. on mai
neral way the ear proportion-	That depends; c
.....	80, 90 and 100-l
irely with 60-lb.	100-lb. on mai
.....	60-lb.
.....	80-lb.
.....	70-lb. main line
.....	This company is
	75-lb.
	65-lb.
	80-lb.
.....	70-lb.
xperiencing the of the latter day tured 15 and 20	80-lb.
	80-lb.
	80 and 90 lb.
ough to answer r ahead of our r yard are used.	70-lb.
fferent weights	Do not expect to Standard now 70
	70-lb.
dgar Thompson n account of its	80-lb.
.....	80-lb. on main lir
.....	75-lb. ASCE sect
.....	70-lb. and 85-lb.
	80-lb.
	80-lb.
.....	With increasing e 90 lb.

RAIL STATISTICS

USE OF OLD RAIL.

We do not deem it advisable at this time to make any recommendation on this matter. The use of old rail is largely controlled by the conditions existing on each road. A large amount is required for renewals of sidetracks and the construction of new sidetracks. It is assumed that most roads will take rail out of main tracks and use it in sidetracks without re-rolling or re-sawing.

Some roads with two classes of track for main lines and branches, where it is desired to keep a high standard of rail on the main lines, will, after the rail is partly worn on the main lines, remove it to the branch lines, and if desirable to make a smooth running track for the branch lines, the rail can be re-rolled and re-sawed.

APPENDICES.

The following appendices are submitted:

A proposed standard specification for steel rail, which was recommended by the American Branch of Committee No. 1, International Association for Testing Materials;

A paper by Mr. Wm. R. Webster, a member of this Committee, submitted at the Richmond meeting of the American Institute of Mining Engineers, held February of this year;

The results of some experiments on the Southern Pacific Railroad, furnished by Mr. J. H. Wallace, Engineer Maintenance-of-Way, and a member of this Committee;

And the statistics which have been collected by the Committee.

We desire to bear record as to the work done by Mr. Fritch, collecting and tabulating the statistics accompanying the report.

Respectfully submitted,

R. TRIMBLE, *Chairman;*
S. M. FELTON, *Vice-Chairman;*
A. W. JOHNSTON;
THOS. PURCELL;
W. T. MANNING;
C. E. WICKHAM;
R. W. HUNT;
J. H. WALLACE;
G. B. WOODWORTH;
WM. R. WEBSTER;

Committee.

APPENDIX.

PROPOSED STANDARD SPECIFICATIONS FOR STEEL RAILS.

RECOMMENDED BY AMERICAN BRANCH OF COMMITTEE No. 1, MAY 1, 1900.

PROCESS OF MANUFACTURE.

1. (*a*). Steel may be made by the Bessemer or open-hearth process.

(*b*). The entire process of manufacture and testing shall be in accordance with the best standard current practice, and special care shall be taken to conform to the following instructions:

(*c*). Ingots shall be kept in a vertical position in pit heating furnaces.

(*d*). No bled ingots shall be used.

(*e*). Sufficient material shall be discarded from the top of the ingots to insure sound rails.

CHEMICAL PROPERTIES.

2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	50 to 59 + pounds. Per cent.	60 to 69 + pounds. Per cent.	70 to 79 + pounds. Per cent.	80 to 89 + pounds. Per cent.	90 to 100 pounds. Per cent.
Carbon.....	0.35-0.45	0.38-0.48	0.40-0.50	0.43-0.53	0.45-0.55
Phosphorus shall not exceed...	0.10	0.10	0.10	0.10	0.10
Silicon shall not exceed.....	0.20	0.20	0.20	0.20	0.20
Manganese.....	0.70-1.00	0.70-1.00	0.75-1.05	0.80-1.10	0.80-1.10

PHYSICAL PROPERTIES.

3. One drop test shall be made on a piece of rail not more than six feet long, selected from every fifth blow of steel. The rail shall be placed head upwards on the supports and the various sections shall be subjected to the following impact tests:

Drop Test.

Weight of rail. Pounds per yard.			Height of drop. Feet.
45 to and including	55		15
More than 55	"	65	16
" 65	"	75	17
" 75	"	85	18
" 85	"	100	19

If any rail break when subjected to the drop test, two additional tests will be made of other rails from the same blow of steel, and if either of these latter tests fail, all the rails of the blow which they represent will be rejected, but if both of these additional test pieces meet the requirements, all the rails of the blow which they represent will be accepted. If the rails from the tested blow shall be rejected for failure to meet the requirements of the drop test, as above specified, two other rails will

ights. Under, ins.	Seconds, accepted.	Variation in weight allowed, %.	Branding.
$\frac{1}{64}$	Specified in order.	½ for entire order.	Name of maker, month and yea rolled in raised letters on side of web. Heat number shall be stamped on each rail.
$\frac{1}{64}$	Specified in order.	.....	Number of charge, name of maker, month and year on side of web in such position as not to be covered by splice bar
$\frac{1}{64}$	.....	1 for individual rail, ½ for whole order, weigh 1 rail per hour.	Maker's name, month and year, railroad's symbol rolled on web; blow number to be stamped on web.
.....	When mentioned in contract 5	.....	Number of charge, year and place of manufacture plainly marked on side of web.
$\frac{1}{64}$	.....	.....	Name of maker, month and year rolled on side of web; heat number to be stamped on each rail.
$\frac{1}{64}$	Specified in order.	.....	Same as R. W. Hunt's.
.....	5 of each month's delivery.	1 for individual rails, ½ whole month's delivery.	Place and date of manufacture to be rolled on side of web; charge number to be stamped.
$\frac{1}{64}$ when rolls are new.	3 of whole order.	.....	Name of maker, month and year with designation of rail rolled on side of web; heat number stamped on side of web, so as not to be covered by splice bar.
$\frac{1}{64}$	.....	.....	Name of maker, month and year to be rolled on side of web; charge number to be stamped on web.
$\frac{1}{64}$	5	.....	Same as R. W. Hunt's.
.....	.....	.....	
$\frac{1}{64}$	.....	.....	Same as R. W. Hunt's.
$\frac{1}{64}$	.....	.....	Same as R. W. Hunt's.
$\frac{1}{64}$	.....	.....	
$\frac{1}{32}$	.....	1%	Maker's name, month and year rolled on web; melt number to be stamped on web.

olis, St. Lou Fairport; Pittsburg & Eastern; Richmond, Fredericksburg &

timore & Ohio; Erie Railroad; Flint & Pere Marquette; Grand Trunk;
ork Central Son Pacific; Wabash.

be subjected to the same tests, one from the blow next preceding, and one from the blow next succeeding the rejected blow. In case the first test taken from the preceding or succeeding blow shall fail, two additional tests shall be taken from the same blow of steel, the acceptance or rejection of which shall also be determined as specified above, and if the rails of the preceding or succeeding blow shall be rejected, similar tests may be taken from the previous or following blows, as the case may be, until the entire group of five blows is tested, if necessary.

The acceptance or rejection of all the rails from any blow will depend upon the result of the tests thereof.

Test Pieces and Methods of Testing.

4. The drop test machine shall have a tup of two thousand (2,000) pounds' weight, the striking face of which shall have a radius of not more than five inches (5″), and the test rail shall be placed head upwards on solid supports three feet (3′) apart. The anvil block shall weigh at least twenty thousand (20,000) pounds, and the supports shall be a part of, or firmly secured to, the anvil. **Drop Testing Machine.**

5. The manufacturer shall furnish the inspector, daily, with carbon determinations of each blow, and a complete chemical analysis every twenty-four hours, representing the average of the other elements contained in the steel. These analyses shall be made on drillings taken from a small test ingot. **Sample for Chemical Analysis.**

Finish.

6. Unless otherwise specified, the section of rail shall be the American Standard, recommended by the American Society of Civil Engineers, and shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with paragraph No. 7, relative to specified weight. A variation in height of one-sixty-fourth of an inch (1/64″) less and one thirty-second of an inch (1/32″) greater than the specified height will be permitted. A perfect fit of the splice bars, however, shall be maintained at all times. **Section.**

7. The weight of the rails shall be maintained as nearly as possible, after complying with paragraph No. 6, to that specified in contract. A variation of one-half of one per cent. (½%) for an entire order will be allowed. Rails shall be accepted and paid for according to actual weights. **Weight.**

8. The standard length of rails shall be thirty feet (30′). Ten per cent. (10%) of the entire order will be accepted in shorter lengths, varying by even feet down to twenty-four feet (24′). A variation of one fourth of an inch (¼″) in length from that specified will be allowed. **Length.**

9. Circular holes for splice bars shall be drilled in accordance with the specifications of the purchaser. The holes shall accurately conform to the drawing and dimensions furnished in every respect, and must be free from burrs. **Drilling.**

10. Rails shall be straightened while cold, smooth on head, sawed square at ends, and, prior to shipment, shall have the burr, occasioned by the saw cutting, removed, and the ends made clean. Number 1 rails shall be free from injurious defects and flaws of all kinds.

Finish.

BRANDING.

11. The name of the maker, the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of the blow shall be stamped on each rail.

INSPECTION.

12. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

No. 2 RAILS.

13. Rails that possess any injurious physical defects, or which for any other cause are not suitable for first quality, or number 1 rails, shall be considered as number 2 rails, provided, however, that rails which contain any physical defects which seriously impair their strength shall be rejected. The ends of all number 2 rails shall be painted in order to distinguish them.

REMARKS ON SPECIFICATIONS FOR STEEL RAILS.

BY W. R. WEBSTER, PHILADELPHIA, PA.

(American Institute of Mining Engineers, Richmond Meeting, February, 1901.)

Opinions still differ widely concerning the requirements, chemical and physical, which should be expressed in specifications for steel rails, in order to secure results satisfactory to both manufacturers and purchasers.

Sir Lowthian Bell is reported as saying last summer, at the London meeting of the American Society of Civil Engineers, that "as he had been twenty-five years a manufacturer of rails, and twenty-five years a director in the Northeastern Railway, he represented both maker and user, and he had at his disposal 35,000 analyses to go upon, in making deductions. From these he could prove, and disprove, everything that could be said for or against any composition of a rail,—a facility beloved by the expert."

The Committee of the British Board of Trade adopted in its report of May, 1900,* the following, with other conclusions submitted by Sir William Roberts-Austen and Professor Unwin:

*Steel Rails: Report of the committee appointed by the Board of Trade to inquire into the loss of strength in steel rails through use in Railways. (Parliamentary Blue Book, May, 1900, pp. 7, 8.) (The committee consisted of Lord Blythswood, chairman, and the following distinguished engineers and experts: Sir Benjamin Baker, Sir Lowthian Bell, Prof. Wyndham Dunstan, Prof. A. B. W. Kennedy, Maj. F. A. Marindin, Mr. E. P. Martin, Prof. Sir William A. Roberts-Austen, Dr. Thomas E. Thorpe, Prof. W. C. Unwin and Mr. E. Windsor Richards.)

"The evidence before the committee indicates what the limiting proportions of carbon, sulphur, phosphorus, manganese and silicon should be. As regards the influence of phosphorus, it is pointed out that, in a broad sense, brittleness of steel does not depend on the total amount of phosphorus present, as that element may exist in steel in at least two different forms, one of which is comparatively innocuous.

"It is very important that all who are responsible for the manufacture or use of steel rails should realize that steel is not the homogeneous mass it is often supposed to be, but possesses a complex structure. The nature of this structure will vary greatly with the mechanical and thermal treatment to which the metal has been subjected. The durability of the rail depends in no small measure on its structure, which may, if the specimens of steel have been suitably prepared, be revealed by the microscope. The peculiar structure of the St. Neots rail, for instance, can be exactly imitated."

Also the following, with others, submitted by Professor Unwin, Sir Benjamin Baker and Professor Kennedy:

"It is very desirable that the mechanical tests to which rails are subjected should be as far as possible standardized in connection with (1) the weight; (2) the section; and (3) the chemical composition of the rail."

After expressing agreement with the conclusions of the sub-committees, the report adds, that, as regards chemical composition, the Committee does not think it desirable "to insist upon too high a proportion of carbon, manganese or silicon in the steel, having regard to the ordinary contingencies of manufacture, and the greater susceptibility of high-carbon steel to thermal influences."

Appendix VII. (p. 74 of the Report) gives the following chemical specifications for rails, proposed by Mr. E. Windsor Richards and approved by Mr. E. P. Martin:

	Minimum, per cent.		Maximum, per cent.
Carbon	0.35	to	0.50
Silicon	0.05	"	0.10
Sulphur	0.04	"	0.08
Phosphorus			0.08
Manganese	0.75	"	1.00

This subject of steel rails constitutes but a single branch of the larger subject, for the investigation of which the International Association for Testing Materials was organized in 1895, at a conference held in Zurich, Switzerland—following a series of similar conferences, held at Dresden (1884), Berlin (1886), Munich (1888), and Vienna (1893). In historic justice, the conference of 1882 at Munich, and its chief promoter, John Bauschinger, should be mentioned as practically originating the movement. The successive conferences had gradually acquired an international character; and at the Zurich conference of 1895 all European countries, except Turkey, were represented, as was also the United States (by an army officer and a delegate from the American Society of Mechanical Engineers). The opportunity thus presented for the formal organization of an International Association was evidently too good to be lost. The objects of the Association, as stated in its statutes, are "the development and unification of standard methods of testing for the determination of the properties of the materials of construction and of other materials, and also the perfection of apparatus for that purpose."

The activity of the American Section of the Association has been creditably shown in many ways. As regards the physical and chemical tests of iron and steel, its work is exhibited in its Bulletins 8 to 17, inclusive, which give the specifications proposed by the American Branch of the International Committee No. 1, for the various forms of iron and steel included in the following list (in which the number of the corresponding Bulletin follows, in parenthesis, the name of each class of material): Structural steel for bridges and ships (8); for buildings (9); open-hearth, boiler-plate and rivet-steel (10); steel rails (11); splice-bars (12); axles (13); tires (14); forgings (15); castings (16); wrought-iron (17).

Concerning these proposed specifications, it need only be said that they have been approved by vote of the Committee as representative of the best American practice, and are submitted for discussion to the technical societies and individual experts of the United States.

In all these departments, the Institute is perhaps best fitted of all our technical societies to discuss at least the metallurgical questions involved, since it comprises not only leading metallurgical chemists and engineers, but also many civil and mechanical engineers competent to consider the conditions presented by each special use of the material. But it has been deemed advisable not to attempt too much; and, therefore, while contributions on other branches of the general subject will doubtless be hereafter, as heretofore, acceptable in our *Transactions,* it is specially desired that our members shall give attention to the specification for rails, given in the appendix to this paper. The following list of papers and discussions, compiled from the *Transactions,* will show how early the Institute took up the subject of the relation between the chemical composition and the physical qualities of the various compounds of iron, and how important have been its contributions to the literature of that subject. I give it here, in the hope that it may stimulate our members to continue the work so well begun, and retain for the Institute in this field the deserved reputation which it now enjoys:

Papers and Discussions on the Nature, Composition, Qualities, Uses, tc., of Iron and Steel, Contained in the Transactions of the American Institute of Mining Engineers, since its Organization in 1871. Arranged in Chronological Order.

Title—	Author.	Volume.	Year.
Manufacture of Iron and Steel Rails	John B. Pearse	I.	1872-3
Rolling Versus Hammering Ingots	A. L. Holley	I.	1872-3
Tests of Steel	A. L. Holley	II.	1873-4
Certain Mechanical Changes in Bessemer Steel	A. MacMartin	II.	1873-4
Investigations on Iron and Steel	Prof. T. Egleston	III.	1874-5
Phosphorus and Carbon in Iron and Steel	Dr. R. W. Raymond	III.	1874-5
Annealing Spiegeleisen	Dr. R. W. Raymond	III.	1874-5
Some Pressing Needs of Our Iron and Steel Manufacturers	A. L. Holley	IV.	1875-6

Title—	Author.	Volume.	Year.
What is Steel?	A. L. Holley	IV.	1875-6
What Steel Is	Frederick Prime, Jr.	IV.	1875-6
The Effect of Manganese in Bessemer Metal	Dr. August Wendel	IV.	1875-6
The Commercial and Scientific Nomenclature of Iron	William Metcalf	V.	1876-7
The Properties of Iron Alloyed With Other Metals	G. H. Billings	V.	1876-7
The Nomenclature of Iron	H. M. Howe	V.	1876-7
The Endurance of Iron Rails	W. E. Coxe	V.	1876-7
The Strength of Wrought Iron as Affected by Its Composition and Its Reduction in Rolling	A. L. Holley	VI.	1877-8
The Chemical Composition and Physical Properties of Steel Rails	Dr. Charles B. Dudley	VII.	1878-9
Does the Wearing Power of Steel Rails Increase With the Hardness of the Steel?	Dr. Charles B. Dudley	VII.	1878-9
On an Apparatus for Testing the Resistance of Metals to Repeated Shocks	William Kent	VIII.	1879-80
The Law of Fatigue and Refreshment of Metals	Prof. T. Egleston	VIII.	1879-80
The Wearing Capacity of Steel Rails in Relation to Their Chemical Composition and Physical Properties	Dr. C. B. Dudley	IX.	1880-1
The Amount of Manganese Required to Remove the Oxygen from Iron After It Has Been Blown in a Bessemer Converter	S. A. Ford	IX.	1880-1
Note on Manganese in Bessemer Rail-Steel	John W. Cabot	X.	1881-2
Iron and Steel as Materials of Construction	General Discussion	X.	1881-2
Notes on the Relation of Manganese and Carbon in Iron and Steel	Alexandre Pourcel	XI.	1882-3
The Management of Structural Steel	Albert F. Hill	XI.	1882-3
Microscopic Analysis of the Structure of Iron and Steel	J. C. Bayles	XI.	1882-3
Open-Hearth Steel Charge Made for Boiler Plate	Alfred E. Hunt	XII.	1883-4
Physical and Chemical Tests for Steel for Boiler and Ship Plates for the United States Government Cruisers	Pedro G. Salom	XII.	1883-4
The Study of Iron and Steel	J. C. Bayles	XIII.	1884-5
The Segregation of Impurities in Bessemer Steel Ingots on Cooling	Prof. B. W. Cheever	XIII.	1884-5
A Theory to Explain the Cause of Hard Centers in Steel Ingots	R. Gatewood	XIII.	1884-5
The Microscopic Structure of Iron and Steel	F. L. Garrison	XIV.	1885-6
The Influence of Temperature in Steel Making on the Behavior of the Ingots in Rolling	John W. Cabot	XIV.	1885-6
The Manufacture of Steel Castings	Pedro G. Salom	XIV.	1885-6
The Homogeneity of Open-Hearth Steel	H. H. Campbell	XIV.	1885-6
Mitis Castings from Wrought-Iron and Steel	P. Ostberg	XIV.	1885-6
Notes on the Constitution of Cast-Iron	Dr. C. B. Dudley	XIV.	1885-6

Title—	Author.	Volume.	Year.
Recent Failures of Steel Boiler-Plates	William Kent	XIV.	1885-6
Soft Steel for Boiler-Plates	A. E. Hunt	XIV.	1885-6
Microscopic Structure of Steel Rails	F. L. Garrison	XV.	1886-7
Two Conditions of Phosphorus in Iron	B. W. Cheever	XV.	1886-7
Certain Conditions in the Manufacture of Steel Rails Which May Influence Their Life in Service	F. A. Delano	XVI.	1887-8
Rail Sections	F. A. Delano	XVII.	1888-9
The Wear of Metal as Influenced by Its Chemical and Physical Properties	Dr. C. B. Dudley	XIX.	1890-1
Aluminum in Steel Ingots	Prof. J. W. Langley	XX.	1891-2
The Tests and Requirements of Structural Wrought-Iron and Steel	A. E. Hunt	XX.	1891-2
The Making of Specifications for Structural Materials	Dr. C. B. Dudley	XXI.	1892-3
Note on Manganese Steel	H. M. Howe	XXI.	1892-3
Observations on the Relations Between the Chemical Constitution and Physical Character of Steel	W. R. Webster	XXI.	1892-3
Segregation and Its Consequences in Ingot-Steel and Iron	A. Pourcel	XXII.	1893
Microscopic Metallography	F. Osmond	XXII.	1893
The Microstructure of Steel	A. Sauveur	XXII.	1893
The Open-Hearth Process	H. H. Campbell	XXII.	1893
Further Observations on the Relation Between the Chemical Constitution and the Physical Character of Steel	W. R. Webster	XXIII.	1893
The Heat-Treatment of Steel	H. M. Howe	XXIII.	1893
The Microstructure of Ingot-Iron in Cast Ingots	A. Martens	XXIII.	1893
Iron Alloys, With Reference to Manganese Steel	R. A. Hadfield	XXIII.	1893
The Physics of Steel	General Discussion	XXIII.	1893
		XXIV.	1893
Pyrometry and the Heat-Treatment of Steel	H. M. Howe	XXIV.	1894
Nickel and Nickel-Steel	F. L. Sperry	XXV.	1894
Note on a Proposed Scheme for the Study of the Physics of Cast-Iron	W. R. Webster	XXV.	1895
Specifications for Steel Rails of Heavy Sections Manufactured West of the Alleghanies	Robert W. Hunt	XXV.	1895
Note on Copper in Iron and Steel	R. W. Raymond	XXVI.	1896.
The Microstructure of Steel and Current Theories in Hardening	A. Sauveur	XXVI.	1896
The Relation Between the Chemical Constitution and Physical Character of Steel	W. R. Webster	XXVIII.	1898
The Physics of Cast-Iron	General Discussion	XXV.	1895
	General Discussion	XXVI.	1896
	General Discussion	XXVII.	1897
	General Discussion	XXVIII.	1898

MW 622

Wheeler Rail

75 lb S.P.Co. Section.

12-1 1900 AAR

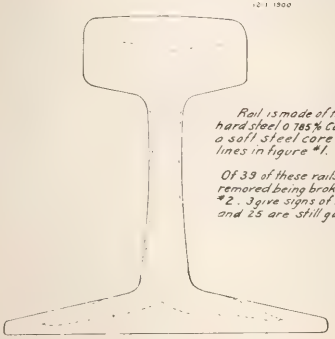


Fig 1

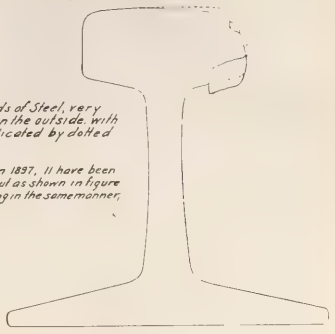


Fig 2.

Rail is made of two kinds of Steel, very hard steel 0.785% Carbon on the outside, with a soft steel core as indicated by dotted lines in figure #1.

Of 39 of these rails laid in 1897, 11 have been removed being broken about as shown in figure #2, 3 give signs of breaking in the same manner, and 25 are still good

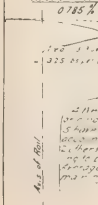
MW 619

Comparative Wear of Wheeler Process and of Ordinary 75 lb Steel Rails

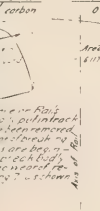
11-26-1900 Full size templets AAR

Laid on outside of 10° curve near Beelville, Aug 15th 1897 Templets taken Sept 4th 1900 37 months service

Wheeler Process Rail 0.785% carbon

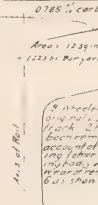


Standard Rail 0.476% carbon

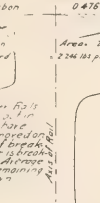


Laid on outside of 5°30 curve West Oakland, Aug 13th 1897 Templets taken Aug 1st 1900 37 months service

Wheeler Process Rail 0.785% carbon

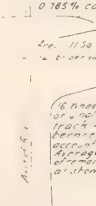


Standard Rail 0.476% carbon

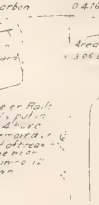


Laid on outside of 10° Curve near Lander July 18th 1897 Templets taken Nov 13th 1900 40 months service

Wheeler Process Rail 0.785% carbon



Standard Rail 0.416% Carbon



Tonnage Of Trains Passing Over Rails

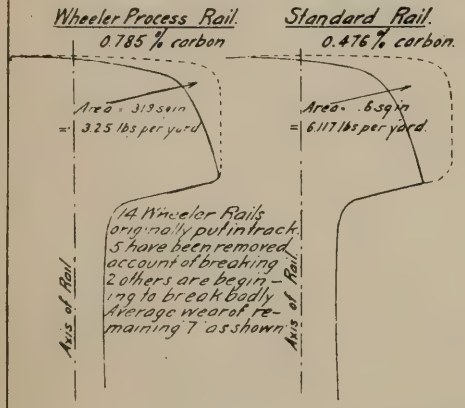
	Rails near Beelville	Rails at W. Oakland	Rails near Lander
Total weight of train during entire time of service	12 309 750 tons	11 083 960 tons	5 360 350 tons
Average per annum	3 332 352	3 594 792	4 590 865
Average per day	10 839	9 985	12 759

MW. 619.

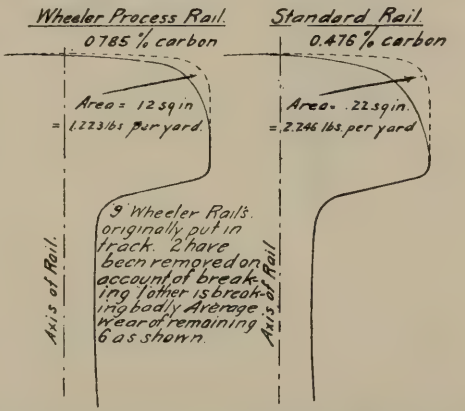
Comparative Wear of Wheeler Process and of Ordinary 75lb. Steel Rails

11-26-1900. Full size templets. A.A.R.

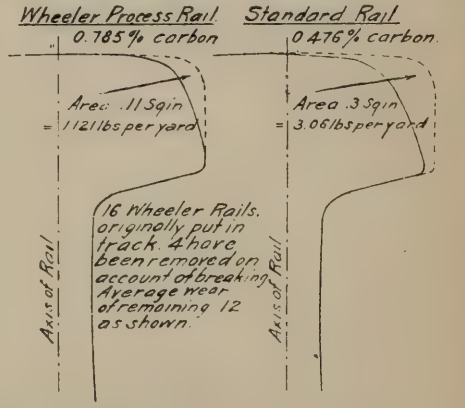
Laid on outside of 10° curve near Bealville, Aug 15th 1897. Templets taken Sept 4th 1900. 37 months service.


Wheeler Process Rail. 0.785% carbon
Standard Rail. 0.476% carbon.
Area = .319 sqin = 3.25 lbs per yard
Area = .574 sqin = 6.117 lbs per yard.
14 Wheeler Rails originally put in track. 5 have been removed account of breaking 2 others are beginning to break badly Average wear of remaining 7 as shown
Axis of Rail.
Axis of Rail.

Laid on outside of 5°30 curve West Oakland, Aug 13th 1897. Templets taken Aug 1st 1900. 37 months service.


Wheeler Process Rail. 0.785% carbon
Standard Rail. 0.476% carbon.
Area = .12 sqin = 1.223 lbs per yard.
Area = .22 sqin. = 2.246 lbs per yard
9 Wheeler Rails originally put in track. 2 have been removed on account of breaking 1 other is breaking badly Average wear of remaining 6 as shown.
Axis of Rail.
Axis of Rail.

Laid on outside of 10° Curve near Lander July 18th 1897. Templets taken Nov 13th 1900. 40 months service


Wheeler Process Rail. 0.785% carbon
Standard Rail. 0.476% carbon.
Area .11 Sqin = 1.121 lbs per yard
Area .3 Sqin = 3.061 lbs per yard
16 Wheeler Rails. originally put in track. 4 have been removed on account of breaking Average wear of remaining 12 as shown.
Axis of Rail
Axis of Rail

Tonnage Of Trains Passing Over Rails.

	Rails near Bealville	Rails at W. Oakland	Rails near Lander
Total weight of train during entire time of service	12,309,750 tons	11,083,960 tons	15,302,950 tons
Average per annum	3,992,352 "	3,594,792 "	4,590,885 "
Average per day	10,899 "	9,985 "	12,753 "
Gross weight traffic per lb wear per yd. Wheeler,	3,787,615 tons or 0.95 years,	3,062,927 tons or 2.52 years	13,651,159 tons. or 2.97 years
do Standard,	2,012,384 " " 0.50 "	4,941,578 " " 1.37 "	5,000,964 " " 1.09 "

OFFICE OF ENGINEER MAINTENANCE-OF-WAY.
SOUTHERN PACIFIC COMPANY,
PACIFIC SYSTEM.

San Francisco, Cal., December 6, 1900.

Mr. Robert Trimble, Chairman Committee on Rail, American Railway Engineering and Maintenance-of-Way Association, Pittsburg, Pa.

Dear Sir:—As a matter of interest to the Association, which I thought you might like to present through your Committee, I beg leave to inclose some blue prints showing the result of an experiment we have been making with what is known as the "Wheeler-process" rail, being rail rolled from steel of two grades and so manipulated that the outer or wearing surface of the rail is high-carbon steel, whereas the inner portion is soft or low-carbon steel.

On drawing M. W. 622 is indicated by dottel lines the distribution of the two kinds of metal. Thirty-nine of these rails were originally put into track at three different points: Fourteen were laid on the outside of a 10-degree curve near Bealville, Cal.; nine on the outside of a 5-degree 30-minute curve near Oakland, Cal.; and sixteen on the outside of a 10-degree curve near Lander, Cal. At the same time, we put in a like number of our standard rails of the same weight and pattern, on the same curves, immediately adjoining the Wheeler-process rails. Templets have been taken each year to show the comparative wear, and the last taken are those shown on blue print M. W. 619. The blue print shows the amount of wear, also the tonnage of trains that passed over the rails.

The rails laid near Bealville are on a long, continuous stretch of 116-foot grade, over which engines of the heaviest type are operated. Those laid near Lander are on one of the few stretches of light grade on our Central Pacific line crossing the Sierra Nevada Mountains between Sacramento and Truckee. The maximum grade on this piece of road being 116 feet to the mile, these rails are also traversed by our heaviest locomotives. The rails laid near Oakland are on level grade and traversed only by passenger trains in one direction, being portion of a double-track line.

The result of the experiment indicates that the wear of the Wheeler-process or hard steel is just about half that of the ordinary soft steel rail, practically the same result being obtained at each of the three points. It will be observed that the wear of the rail near Bealville is very much in excess of that of the rail near Lander, although the tonnage over the latter was about 25 per cent. greater. This, I think, is accounted for by the fact that the rail near Bealville, being on the maximum grade, engines passing over it work very hard and are almost constantly using sand, which gets in between the wheel flanges and side of the rail, causing excessive wear. At Lander, on the other hand, the grade being very light, no sand is used; hence the wear is only that due to the friction between the wheel flange and the rail.

As noted on the blue print, a number of the Wheeler-process rails have failed, usually in the manner indicated in Fig. 2, drawing M. W. 622; indicating that the union between the hard and soft steel is not perfect. Perhaps this defect can be overcome by improved process of manufacture. Yours truly,

J. H. Wallace, Engineer Maintenance-of-Way.

The President:—We will ask Mr. Trimble, the chairman of the Committee, to open the subject.

Mr. Robert Trimble (Pennsylvania Lines):—Your Committee believes that at least three suggestions are made in this report which should be acted upon, and if they are approved, a sincere effort should be made to put them into use. The first is as to the use of long rails. At the present time we may say that the stand-

ard length of rail is 30 feet. There are some variations from this practice. Some roads use 32 feet; some 33 feet; some 45 feet, and some 60 feet. The Committee recommends 33 feet as a standard. No doubt there will be departures from this standard in the way of experiments. Personally I am in favor of a long rail, where it can be used economically, and would like to use a rail as long as I could get it, in order to reduce the number of joints, but we must consider the matter of economical transportation. We have, therefore, fixed 33 feet as being the standard length.

The Committee also recommends the use of fewer sections or weights of rail. It is to be hoped that during the coming year no member of this Association will ask the railmaker to make him a rail that weighs 59 pounds to the yard, or 61 pounds, or 66 pounds, or 67 pounds. We ought to look to some figure such as 60 pounds, 70 pounds and 80 pounds to the yard. We also recommend the use of the expansion tables submitted.

As regards the specifications, which are submitted as an appendix to this report, we wish you to understand clearly our position. We do not submit them to this meeting for adoption, and can hardly say that we submit them for discussion. It is only recently that these specifications came into the possession of the Committee, and we did not have an opportunity to thoroughly discuss them at our Committee meeting. We decided to submit them to the Association as a matter of information. We propose to use these specifications as a basis for making inquiries, and when we submit our report next year we think possibly you will be in shape to discuss the specifications.

We believe that some substantial progress has been made in the manufacture of rails during the past year; also, that the doctors on the subject of chemistry and mechanical manipulation of rails are getting a little closer together than they were a year ago. If we read correctly the signs of the times we will we believe get a better rail, and one of the things that is bringing this about is the finishing of the rail at a lower temperature. There are two processes in use by which this is brought about, one being known as the Kennedy-Morrison process, used by the Carnegie Steel Company. At that place, after the rail has taken a certain number of passes, the rail is detained for a time and allowed to come to a certain temperature, and after that is passed on through the finish-

ing passes, and we have the rail finished at a lower temperature than formerly. At the Maryland Iron & Steel Company they do not have this arrangement of detaining the rail in progress of being rolled. Their progress is continuous, but at the same time they are rolling rails at a lower temperature and getting nearly identical results with those obtained by the Carnegie Steel Company. It is brought out clearly in some illustrations in the last number of the Railroad Gazette, which show that at the Maryland Iron & Steel Company they are getting a fine-grained rail with a continuous rolling at a slower speed, similar to the rail that the Carnegie people are getting by detaining the rail. A glance at the microscopic sections would indicate that the Maryland Steel Company's section is fully as good as the Carnegie Steel Company's section, if not better. Of course it is hardly fair to draw that conclusion from a few illustrations. In regard to the statistics, our Committee has received a large number of replies to our circulars, and the statistics are a most interesting part of this report. We do not think we can discuss them intelligently at this meeting, but we should look them over after we get home. There are some conclusions which the Committee has drawn from these statistics, in which you may or may not concur. We should endeavor to classify the statistics to see what conclusions can be drawn from them. They are submitted as a basis for the recommendation of the use of fewer sections. We draw the conclusion from the statistics that it is not necessary to have so many different weights of rail.

In regard to the use of the American Society sections, we have some information from the rail manufacturers which came to hand after the report was printed, which indicates that probably 70 per cent of the rail rolled during the past year is of that section. The Committee would like to have you look at some sections that Mr. Manning presents. He is a member of the Committee and you will note that the conclusion the Committee has drawn from the statistics is somewhat different from the practice Mr. Manning would recommend, which is an unequal-headed rail, and he makes an interesting showing. We would much rather you would order some of Mr. Manning's unequal-headed rail during the coming year than to buy 59-pound or 61-pound rail. We will learn more from that than from the other. I may

say in closing that the entire Committee unites in making the recommendations.

Mr. H. G. Prout (Chief Editor Railroad Gazette) :—As no one else seems inclined to discuss this important report, I will venture to say a few words. It strikes me we have arrived at one of the epochs in the history of the development of the rail. As you are all aware, after a great deal of discussion the American Society of Civil Engineers adopted in 1893 a standard section, which has come to be known by the name of that Society. The main doctrine embodied in the American Society's section is what was known as a balanced section. That is to say, it gave such distribution to the metal as would equalize somewhat the rate of cooling as between the head and the flange. It is a well-known fact there has been some disappointment in the results. As the heavier sections have been introduced the railroad companies have not got the wear out of the heavy sections they had expected to get, and it has become a question whether or not it is worth while to spend so much money for 90, 95 or 100 pound rails. Now comes in a new set of conditions, one of which is the finishing at a lower temperature, of which the chairman of the Committee has spoken, and another is the rerolling of the rails. As a result of the realization of what we may perhaps get out of these new conditions, the Committee makes the suggestion that perhaps it would be better to change the section in order to adapt it to these new conditions which have arisen and which seem practicable and promising. As to whether the section can be profitably modified, with a view to getting the greatest benefit out of these new conditions, I am not prepared to say. The Committee has no doubt considered that very carefully. As I said at the outset, it seems as if we had arrived at another one of the epochs in the history of the development of the rail, and if it is desirable, in order that we may have the benefit of the new discoveries, to change the section which was adopted after so much study, we ought to face the music and change the section.

There is another point suggested as possibly coming in with the methods of finishing the rails at a lower temperature, namely, that you will get a rail which will answer the purpose without running up the carbon, as has been the recent tendency. I should expect it would be a mistake to rely upon slower and cooler fin-

ishing in order to get a better quality of rail, and sacrifice the advantages of higher carbon. I should think that we had better have both, and I can see no sufficient reason why we should not have both—finishing the rails at a lower temperature and also retaining the high carbon.

Before I finish I would like to call your attention to a suggestion made by Mr. Baldwin of the Pennsylvania Steel Company, which seems very pertinent. It is to the effect that the engineers of the railroads can coöperate advantageously with the manufacturers of rails by thorough and systematic records. The suggestion is that the users of the rails should be provided with an accurate detail history of the rail during its manufacture, and then certain rails out of each lot to be painted and put in the track, and the wear of the rails noted by an instrument for ascertaining that wear. The form of the instrument is a matter of the least consideration for him. That is quite unimportant, so long as you get an accurate determination of the wear of the rail. Then, having collected the mill history of the rail, and going right through and ascertaining the comparative wear of the rail, you are in a position to compare and proceed to generalize, and know something accurate as to the results to be obtained from certain processes and certain mixtures with which you have started.

Mr. C. S. Churchill (Norfolk & Western):—I wish to supplement the statement of the chairman of the Committee. A year ago, before this Association, the statement was made we could not get rails rolled at a lower temperature without paying more money, but it was agreed it was a very desirable thing. I think everybody went away from here with that point in their minds, that we should all try to get a harder rail by having the rail rolled at a cooler temperature. Whether this Association had anything to do with the results or not, I think that such a desire emanating from an Association like this did have some weight. It has come to pass, however, that we get rails today cheaper than we did a year ago, and we are able to get them rolled at a lower temperature. The Pennsylvania Railroad was one of the first to adopt a specification containing this clause: "The number of passes and speed of trains shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will

not exceed that known as red hot, and preferably a dull red." We asked for bids from the railmakers on this specification and we got quite a number, all at the same figure, stating that they would conform to that clause closely. We have already received one-third of our rails for this year, conforming closely to that requirement, and we are receiving another third from another mill. The first lot was from the Pennsylvania Steel Company—Maryland mill. We think these are a good lot of rails and we are going to try them and judge of their wear. The second lot came from the National Steel Company, which conformed closely to above paragraph, and the next allotment will be from the Carnegie mills, the rails being made under the Kennedy-Morrison process. There is no variation in the price and our experience shows that the railmakers are as ready as we are to improve the rail, if we are only firm in our request for that improvement.

One point that came up was, what was actually being done at the different mills. I sent my inspectors to a number of them and found that whereas the allowance made for contraction of the rail at the time it left the saws was at least 6 inches for a 30-foot rail, we have received them under above specifications with an allowance considerably less than 6 inches and as low as 5½ inches, and this shows that the temperature of the rail at the time it left the saws in our case was lower than it has been in the past.

Mr. E. F. Wendt (Pittsburg & Lake Erie):—I move that the recommendation of the Committee, as far as it relates to the purchase of longer rails, be adopted as recommended practice. It seems to me that the recommendation of the Committee that rails less than 33 feet long should not be purchased is a very conservative recommendation. I favor the purchase of longer rails, even as long as 60 feet, but I do not believe that the Association at this time should adopt any one length as a standard. In view of the fact that most of the gondola cars in the country are 34 feet long, or even longer, it seems reasonable to believe that the railroads would have no difficulty in transporting 33-foot rails; therefore, until such time as a greater number of long cars are used throughout the country, it will be necessary for the railroads to purchase rails in such lengths as may be conveniently transported.

In making this motion, I wish to commend the report of the Committee, because it represents the concensus of opinion of all the members of the Committee. This feature of the report should be especially noted, because many of the committees, in making their reports, failed to agree as to their recommendations, and even failed to submit to the Association that which was a committee report at all. It seems to me that the Committee on Rail and the Committee on Yards and Terminals are both deserving of the commendation of the Association, because the data which the individuals collected was unified into one report.

I believe that the Association would do well in adopting the three recommendations made by the Committee on Rail, as they are founded on good judgment and are certainly very conservative.

Mr. Trimble:—The Committee would like to change the recommendation that the minimum length be 27½ feet, to 27 feet; it was an error to put the half foot in.

Mr. Lum:—Would it not be better to wait and obtain a letter ballot on the subject of length of rail also?

Mr. Trimble:—We should not wait to take a letter ballot on that matter. We have gotten to the place where we think we should take a step in advance, if we can do it. The facts are that at least ten prominent railroads in the country today are buying rails 33 feet in length, and the rail manufacturers are not charging any more for 33-foot than the 30-foot rail. The Bessemer & Lake Erie road, which you might say is dominated by the Carnegie interests, is using that length of rail. The Big Four, Michigan Central, the New York Central, and other roads are also using that length. We think we are ready to vote on this matter today.

Mr. Lum:—Is there any particular reason for limiting the length of the rail to 33 feet? Might it not be 34 or 35 feet? Undoubtedly the matter of transportation has something to do with it, but most of the flat cars which are being built are 34 feet, and many of them 40 feet long. If the matter is to be settled by vote, perhaps we might make the rail a little longer than 33 feet.

Mr. Trimble:—A very great number of cars have been built in the last few years which are 34 feet long, and many roads

are building that length now. We could get a rail 33 feet 6 inches, or 33 feet 8 inches long into that car, but we cannot well get a 34-foot rail into the car, unless you increase the cost of getting the rail out. If you were to try to get a 34-foot rail out of the car, it would jamb at one end and cause trouble. If you put a 33-foot rail into a 34-foot car there is plenty of room to get it out without difficulty. That is the reason the Committee recommended 33 feet.

The President:—With reference to the length of rail, as I understand it, it is, in the first place, a question of transportation, and, secondly, a question of getting it manufactured without an increase in cost. The rail mills situated in different parts of the country, it is understood, can and are willing to furnish a 33-foot rail without additional cost per ton. There are at present sufficient 34-foot cars in the service of the various roads to transport it. The two factors referred to have heretofore limited the length of rails, but now I see no reason why a rail should not be longer than 30 feet. I think everyone will agree that we obtain the greatest economy with the longest possible length of rail.

Mr. D. D. Carothers (Baltimore & Ohio Southwestern):—On our road we use for road-crossing rails 60-foot rails and 33-foot rails at other points. Whether it would be well to incorporate in the recommendation 60-foot rails to avoid breaking joints in the road crossing, I do not know.

Mr. H. D. Miles (Michigan Central):—I would like to hear the opinion of the Committee on the advisability of using 60-foot rails. The chairman states that the principal reasons why long rails are not used is on account of lack of transportation facilities and processes of manufacture. I had occasion to see some 60-foot rails in service on one of the important eastern roads. The rail was kinked—I do not know that it was a set kink—but it was in a very uneven line. The supervisor informed me that the condition of the track was due to the use of 60-foot rails and stated further that the road was taking these rails out as rapidly as possible and placing them on sidetracks. If there is any point in this matter worthy of consideration, I would like to hear it discussed.

Mr. J. H. Abbott (Cleveland, Lorain & Wheeling):—We have just taken out about 10 miles of 60-foot rail and replaced

it with 30-foot rails, from the fact that we found the joints were harder to take care of in the 60-foot rails than twice the number in the 30-foot rails, and also because of the difficulty in handling the long rails, taking care of the spiking, etc. We only use them now on sidetracks.

Mr. Churchill:—I am interested in 60-foot rails, having gone into their use to a considerable extent in 1892. We have worn them out on our road under the heavy traffic due to flange wear on curves. We put in 65 miles. There was no expense connected with the laying or maintenance that was extraordinary in any way. The single question was first cost, as the rail mills refused to furnish these rails without a premium of $2.50 a ton. The transportation matter came up, but that was not serious; it simply meant extra care in loading. The matter of laying the rails on curves of 4 to 6 degrees was not difficult, and it was, if anything, easier to lay a curve with 60-foot rails than with 30-foot rails. They have given excellent service and have been taken out after very remarkable wear when one considers the tonnage that has gone over the rail. The tonnage basis is the only correct way to figure rail life.

On the manufacturer's side there is a different question. The 60-foot rail does not cool straight, and very great care is necessary at the mill to see that they are not punished too hard in straightening. The manufacturers are probably correct in their statement that they cannot at present make 60-foot rails as cheaply as they can 30-foot rails.

Mr. Abbott:—We found the matter of bolts breaking with a 60-foot rail gave us a good deal of trouble. The travel of a 60-foot rail seems to be greater than a 30-foot rail, and this is also true of the expansion. An added reason for replacing them on our road was our desire to put on the main track an increased weight, and, not wishing to try any experiments, it was thought best to replace the 60-pound rail with an 80-pound rail. The range of temperature in Ohio is 90 degrees. We allowed a quarter of an inch between each rail for expansion.

Mr. G. W. Kittredge (Cleveland, Cincinnati, Chicago & St. Louis):—The motion before the house is the vote on the two lengths of rail—33-foot length for the regular rail and 27-foot as a minimum. I am prepared to vote on the 33-foot rail, having

been one of the pioneers in the use of that length of rail, but I would like to ask for some information as to why 27 feet was figured on as a minimum. We use rails down to 26 feet with very good results. I would suggest, if it is going to cause any delay or unnecessary argument, that the motion be amended and we vote on each length separately.

Mr. Trimble:—The Committee did not give the matter of the short rail much attention. There are a number of roads that use rails 27 feet in length, and we assumed they would want to go to that as a minimum. We have not fixed the variations between 33 and 27. Some roads might want to use the 33-foot, 31-foot, 29-foot or 27-foot; another road will use 33-foot, 30-foot or 27-foot. There is six feet of variation, and the recommendation allows you to make the variations you see fit. As far as the Committee is concerned, I do not think it would object to eliminating for the present voting on the 27-foot length. We are interested in a standard of 33-foot length. We think the minimum length will be worked out by each company, at least for the present, according to its need.

In regard to the use of the 60-foot rail, it has fallen to my lot for four years to make each year an inspection of 20 miles of 60-foot rail as laid on our lines. We looked into the expansion matter and laid the rail as close as we dare, realizing if we had too much of an opening there would be a battering at the joints, and we wanted to avoid that. I do not know the conditions under which the rail was laid which the gentleman has just said had to be taken up. He admits, however, he had to take it up on account of wanting to increase the weight of his motive power, and I think that had more to do with taking it up than the failure of the 60-foot rail to do its work. If it had been on a sharp curve or steep grade, and had not been properly held in place with a sufficient number of anti-creeping devices, I would expect trouble with it; but taking an ordinary grade up to 25 or 30 feet per mile, and the ordinary curvature of 1 to 3 degrees, possibly 4 degrees, I cannot see that there is any difficulty at all in regard to the use of a 60-foot rail. We have looked into the joints carefully and they are not harder to keep up than the joints in the 30-foot rail, and are no more battered than the joints in the 30-foot rail. There must be a sufficient number of anti-creeping devices used with

the 60-foot rail to prevent it from creeping; but if you take these precautions there ought not to be any difficulty in its use. We do not use more 60-foot rail on account of the cost. The mills require so much more for rolling them that we cannot afford to pay it. The transportation matter comes in also. It is a little more expensive to haul a 60-foot rail than the 30-foot rail, although the difference is hardly appreciable.

Mr. W. M. Camp (Editor Railway and Engineering Review):—I would like to ask the chairman how many anti-creeping devices he uses on each 60-foot rail, and whether they slot-spike the joint splices.

Mr. Trimble:—They are generally used at the middle of the rail and opposite the joints. We break joints with the rails and put anti-creeping devices opposite the joints and against the middle of the rail.

Mr. F. B. Harriman (Illinois Central):—I have not heard anything said as to what the limit is at which the mills will manufacture a rail at the same price as the 30-foot rail. Some roads could handle a 38-foot rail on account of having a large equipment of 40-foot cars. If we could get a 38-foot rail manufactured at the same price per ton as a 33-foot rail, would not that be a better rail for us to use?

Mr. Trimble:—The chairman of the Committee is not able to answer that question, but we feel sure there are not enough 40-foot cars in use today to justify us in fixing that length. We would be glad to make it 40 feet if we could transport them.

Mr. F. H. McGuigan (Grand Trunk):—The chairman of the Committee has given very good reasons why we should have a 60-foot rail. His experience indicates that it is a satisfactory rail, and it seems to me the difficulty of transportation is easily overcome by using two cars to transport the 60-foot rail. My belief is that even at an extra cost of $2.50 per ton the 60-foot rail is more economical in the end than the 30-foot. I would be glad to see the 60-foot rail more generally used.

The President:—At the present time there are not enough 40-foot cars in use to fix 40 feet as the standard length. We should be glad to make it 40 feet if we could transport it. The question of transportation is a serious one, and for this reason, I presume, less than 5 per cent of the rails are transported on flat

cars, being generally handled in gondolas or stock cars. Only roads having direct access to the mills are able to have their rails delivered on flats. Roads located west of the Missouri River would be obliged to send their own flats to the mills on which to load the rails.

Mr. W. K. McFarlin (Delaware, Lackawanna & Western): —I do not see why this Association need adopt a standard length of rail. If one road has a 40-foot rail and another a 50-foot rail, what difference does it make? I see no reason whatever for recommending a standard length of rail for all roads. Let each road take what they can haul and what they can buy. Rails are never used in interchange. It is not like a standard length of car.

The President:—There is a peculiar reason for the adoption of a standard length. The 30-foot length has been impressed upon us for many years. If each of the members here in his own department would use such length of rail as he might determine upon, it would be a very easy matter, but I presume if nine out of ten of the members here who have charge of maintenance should go to their General Manager with a proposition to shorten or increase the length, the first question asked would be, "What other roads are doing it? Why do you want to increase the length?" Railway managers are conservative, and do not ordinarily want to break away from the standard sizes. If this Association would indicate the desirability of increasing the length of rail only three feet, it would enable a good many of our members to induce their roads to break away from the 30-foot length to which they have been tied down to.

Mr. McFarlin:—I would like to use a 60-foot rail, or a 100-foot rail, if I could get it, and because another man cannot use it, that is not a reason why I should not.

Mr. McGuigan:—I want a long rail, as long as I can get it, and I believe we will reach it after awhile. The rolling mills have been opposing it for years, and not the railroads. If we adopt a standard of 33-foot, I fear they will endeavor to hold us there.

Mr. Mountain:—I agree with Mr. McGuigan's views. I was also glad to hear the chairman of the Committee say he preferred a long rail, and I would like to see rails of 45 and 60 feet in length adopted.

Mr. D. W. Lum (Southern Railway):—It was understood last year at our meeting that these matters were to be thoroughly threshed, and a consensus of what was good practice was to be reached, and then the length of rail most favored was to be recommended as a type, not as a standard. We could then go to our General Managers and say the sense of the meeting is that this is good practice. The General Manager might not recognize any responsibility to the Association, but he would have the indorsement, from which he could deviate at his pleasure, and for that reason I think we ought to arrive at some understanding of what is good practice.

Mr. Manning:—This subject was threshed over at Detroit two years ago by the Roadmasters' Association, and they adopted the 33-foot rail as the standard. They are practical men, who handle the rail, and some consideration is due their views.

Mr. C. A. Wilson (Cincinnati, Hamilton & Dayton):—In considering this matter and making the recommendation, has the Committee confined itself to the question of the manufacture and transportation of the rail, or have they made any investigation as to the place the rail was to take in the track, in renewing the present rails, with reference to spacing of ties, etc.?

The President:—They want a long rail, but have recommended the 33-foot length as the practicable length for the present on account of the manufacturing difficulties and transportation. As far as the spacing of ties is concerned, in relaying rails, even with 30-foot rails, ties must be respaced anyway, as joints will run ahead or fall short.

Is there anything further on this subject? We have taken up a good deal of time. The motion is on the adoption of the recommendation of the use of a minimum standard length of rail of 33 feet. Are you ready for the question?

Mr. Dauchy:—I would like to ask if the motion was put that the rails are recommended as 33-foot standard?

The President:—As a minimum standard—that is, to take the place of the present 30-foot standard. It is optional with the individual members to use 30, 40 or 60-foot rails. It is simply an endeavor on the part of the Committee to get away from the 30-foot length. My own views on the subject are that I would rather have a 60-foot rail than a 30-foot; but I think we will

get to the 60-foot rail quicker by getting away from the 30-foot standard.

Mr. Carothers:—Would it be impracticable to secure 60-feet rails in large quantities at this time, without necessitating the rebuilding or remodeling of the mills? Are the manufacturers in position to make them?

The President:—They are, but ask for an increase of $2 per ton. All in favor of the motion will signify by saying aye: contrary no. The motion is carried.

The next recommendation of the Committee is in regard to the amount of expansion to be used. Do you desire to take any action on that?

Mr. Carothers (Baltimore & Ohio Southwestern):—I inquire of the Committee as to how the thermometer is to be used. It says it is to be applied to the rail.

Mr. Trimble:—You can buy a thermometer with a bulb that can be laid on the rail, and take the temperature on the rail. Of course, if you want to, you can guess within 10 or 20 degrees of the temperature, but if you want to lay the rail properly you will not guess at the temperature. The Committee understands that the aim of this Association is to endeavor to find out what is good practice and then endeavor to have it made the general practice. It would seem to be good practice to allow for such expansion as the Committee have recommended. Of course, if you lay your rail too close, in warm weather there is danger of kinking, and we have made the recommendation so that we do not expect you to have any trouble of that kind.

Mr. McDonald:—I move the adoption of the Committee's recommendation in regard to expansion.

The President:—You have heard the motion—are there any remarks on it? I think you have all made up your minds in reference to this, and further discussion will therefore not be necessary. All in favor will signify by saying aye, and contrary no. The motion is carried.

The only other recommendation made by the Committee, which it does not seem to be thoroughly decided on, is the question of weights and sections. It does not seem that we are prepared to pass on that resolution in regard to confining ourselves to any one section or any particular series of sections. It would

seem enough, for the present at least, until we have gone into the matter further—to take the report of the Committee and select such weights and sections as the majority of the roads are using. There is no question, of course, but that we should confine ourselves to as few sections as possible, but it does not seem to me that we are prepared at this particular time to settle on any specific weights, although the members of the Association may disagree with me. We would be glad to hear from any member on the subject.

Mr. E. E. R. Tratman (Resident Editor Engineering News):—In regard to the proposed section, I think that should be taken up in coöperation with the American Society of Civil Engineers, as otherwise we might introduce the confusion of two standards—the old American Society standard and the new Maintenance-of-Way standard. I do not think we should try to change their section without coöperation with them, and so prevent the adoption of two sections. That would be discourteous at the best.

Mr. Trimble:—It is with a great deal of hesitation that the Committee refers to the matter of changing the section, and you will notice we have not made a definite recommendation. We were not quite ready to do that. I think it was in December that the Carnegie Steel Company commenced to roll the rail at the lower temperature, and that is where we commenced to get definite information as to the difficulty of rolling at the lower temperature. The flanges of the rail at the lower temperature become black, and we have difficulty in getting a perfect pattern. We will take this matter up with the railmakers and see what can be accomplished. The American Society sections had a pretty hard fight to come into general use, and last year about 70 per cent of the rail rolled was the American Society section. The section is coming into greater use each year, and if we make a recommendation now to change the section, the sooner it is done the better. We expect to make a definite recommendation at the next meeting. I do not see how we can take the matter up with the American Society. We are responsible to this Association, and another committee is responsible to the American Society. There is now no standing committee on the subject in that society, and I think we can leave that society out of consideration for the present.

In regard to the higher and lower carbon, I am not so familiar with the chemistry end of the proposition as Mr. Webster, but my understanding is that the heat treatment has a great deal to do with the final results in using high and low carbon. I agree with Colonel Prout that probably we can with this heat treatment use a little higher carbon and improve the quality of the rail.

In regard to the wear, there was something said about making a record of that. At the time the American Society of Engineers formulated sections they went into the matter of wear pretty thoroughly, and they published with the report of the committee a great deal of information on that subject. The matter has not been given proper consideration by the railroads. It is only within the past two or three years that they have been taking this matter up in a scientific way. On our own lines now we have rails marked as Colonel Prout has indicated, and at regular intervals we take sections of the rail to show the wear from year to year. In addition to the instrument mentioned by Colonel Prout there is an instrument of German manufacture which I first saw at the Carnegie Steel Company. It is an instrument which calipers the entire head, and it is clear to me that this would give us better results than the instrument spoken of by Colonel Prout. It is a little difficult to manipulate. You have to fasten it to the rail, and send out flagmen. It is of such a nature that it cannot be taken off in a second or two, but it is an instrument that would give very good results, and by identifying the rails and then going through them once in six months you will be able to get some definite results as to high carbon rails, low carbon rails or rails of other kinds that you may be experimenting with.

Mr. Wm. R. Webster (Consulting and Inspecting Engineer):—At the first annual convention of this Association, Mr. Reed's description of the old and present methods of manufacturing steel rails was given, with his deductions. He referred to the outraged and crushed particles in the steel not being allowed to come to rest at any time during the present method of manufacture, and further said:

"Owing to all this haste the rails finish at a high temperature, and the heads practically anneal and soften themselves on

the cooling beds, but the annealing is useless and too late, as the mass of metal in the heads is, of course, open, friable grain and poorly fitted to stand the abrasive action of the car wheels under heavy loads."

This is not annealing. It is only slow cooling and tends to increase the size of the grain in the rail that has been finished too hot in rolling. It has been shown time and again that to anneal steel it must be allowed to cool down below the point of recalescence and then heated up to the proper temperature above that point. Simple as this fact is, it has often been overlooked, and a few years ago it was common practice to pile very heavy plates, one on top of the other, as they came from the rolls, in order that they would hold the heat and thus be annealed. It has been proven that this delayed cooling made the plates much worse than they otherwise would have been. But, on the other hand, that by holding the plates back in rolling, in order to finish at a lower temperature, they were very much better. Intentionally, in this case, the "particles were outraged and crushed," at the proper temperature, of course, and thus drawn out, producing a very superior plate. Recent practice has shown that the same improvements are produced in rails by this delayed rolling.

Another important matter is to have a satisfactory check on the finishing temperature of the rails. It is not of much use to say that the rails must be finished at a dull red or any other particular color, as opinions differ as to just what a dull red is, and in the daytime it certainly looks very different than at night. The best check we have is a simple one that I have advocated for some time, that is, the amount of shrinkage that takes place in a 30-foot rail from the time it is cut at the hot saw until it reaches the normal temperature. Just how many inches it is proper to allow could be easily decided by experiment, and introduced into the specifications.

It has been said that the "only way to get a satisfactory rail is to reroll it." The heating of the cold rail to the low heat required for the slight reductions in rerolling, anneals it, and the work of rolling at this low temperature still further improves and toughens it. If a piece was taken from the cold rail to be rerolled, another from the rail after it has been heated, and a third from the rerolled rail, these pieces, when broken under the drop, would show the improvements in the structure referred to.

The ordinary method of rolling with the proper amount of work on rails at a low enough temperature will produce just as good rails as by rerolling; but on account of the flanges losing the heat so much sooner than the head, it is difficult to do this, particularly with the heavy sections. In order to overcome this difficulty and finish the rails at the proper temperature, Mr. John Fritz suggested some years ago taking the rails before the final passes and putting them in a furnace that was kept at a low heat. This would allow the heads to cool down and heat the flange up to the proper temperature. The condition of the rolling in the final passes would be the same as in the rerolling, except that the slow cooling of the heads in the furnace would make a much larger grain, at the same temperature, than the cold rails that had been heated up to this low temperature. Therefore, more work would be required in the last passes to produce the same results in the finished rails.

The Carnegie Steel Company have, at considerable expense, changed the position of the finishing rolls at the Edgar Thompson mills in order to hold the rails back before the last pass. The rails are so arranged on the skids that the head of one rail is kept in contact or close to the flange of the rail next to it. This keeps the flanges hot while the heads are cooling down, and much better results are obtained than in their ordinary method of rolling. But in any of these methods of rolling, the thin flange is the troublesome feature. This can be overcome to a large extent by putting more metal in the flanges of the heavier sections, in order to carry the heat longer and allow the work of rolling on the head at a low enough temperature to produce the tough, good-wearing steel of the old, lighter-section rails.

What has been said indicates some of the troubles to be encountered in this problem. In addition to these, we have, of course, the effect of the chemical composition on the finished rails. There are yet wide differences of opinion as to where to draw the limits for almost any of the elements, and the composition that may give the best results with the present methods may have to be modified for rails finished in rolling at a lower temperature. From statements made, there seems to be something wanting in the present specifications in connection with the present methods of rolling, and in this respect they resemble Colonel

Mulberry Sellers' celebrated eye-water, its features being the "lacking ingredient," and "the more you use the more you need."

In my business with railmakers, as an inspector of rails, I have not found them as arbitrary as stated. In many cases on foreign specifications for rails they have met requirements of specifications much more severe than any American engineer has called for.

President Wallace:—We have not yet had any discussion of this part of the report referring to the use of old rails, and if Mr. McKenna is in the hall we would be glad to have him give us a five-minute talk on the progress that has been made in the rerolling of old rails.

Mr. E. W. McKenna:—Our experience in the rerolling of old rails goes back about five years. Our first work was done in 1895 in an experimental way in the mill of the Illinois Steel Company at North Chicago. In that year we made about 3,500 tons of rails, which were placed on the tracks of five different railroads, in some places where the stress was very great, on switching leads, for instance. Following that exploitation there was nothing done till 1897. The wear that the experimental rails had, had demonstrated the fact that the physical properties of the rails were at least as good as original rails, so we went on and established our plant at Joliet, and later one at Kansas City, and we are now building one on New York Bay. We have already made about 100,000 tons of rails, and the experience of our customers with the renewed rails seems to have been very happy, because they all speak very well of them, and in almost every instance have come back for more work. The practical feature of our method consists simply in heating a full length of rail in a furnace 12 by 34 feet, to a temperature of 1,700 degrees, when the rails are drawn from the furnace. They have three passes—the upsetting pass, for closing the rail up so it can be drawn out to its original fishing standard, the roughing pass and the finishing pass. The rails, as demonstrated by tests that were made, are finished at 1,480 degrees, which is a higher heat than we expect to use. We expect to finish at 1,400. The manner of heating these rails uniformly we found to be exceedingly difficult until we devised a furnace that would give us an equable heat, and now we are finishing the rails at a perfectly uniform

heat. The reduction of section has been as low as 6 per cent and as high as 10, the average being about 8. In many instances the rails are drawn out to 32 feet, instead of cutting them off at a standard length. Those are the principal features connected with it.

The heaviest section we have rolled is eighty pounds. The life of a rail is not measured by one life. It is measured by the number of times it can be renewed. This section that we are discussing will have advantages in rerolling which I consider quite as great as making the original rail at a low temperature. All our experiments in the way of chemical tests show that there is no disturbance of the chemical property of the rail, and the experiments that we have made at various times all show a very considerable improvement in the structure. The physical wear of these rails shows that they have been uniformly improved in quality. Mr. Woodworth, of the Committee, has been in personal touch with some of them that have been in the track since June, 1885, and he can state that they have shown remarkable qualities.

The meeting adjourned until 9:30 a. m., Thursday, March 14.

THURSDAY, MARCH 14, 1901.

The President:—Balloting for the election of officers will now be declared closed, and D. D. Carothers, C. E. Lindsay and J. H. Wallace are appointed tellers. The ballots will be turned over to these gentlemen by the assistant secretary in the anteroom, and the tellers will make their count and report to the Secretary.

The first order today is the report of the Committee on Water Service. The chairman of the Committee will open the discussion with such remarks as he desires to make in connection with the report.

REPORT OF COMMITTEE ON WATER SERVICE.

To the American Railway Engineering and Maintenance-of-Way Association:

The work of this Committee as outlined by the Board of Direction is subdivided under three general heads, and the Committee thought best, in planning the work, to divide the Committee into three sub-committees, each one to have charge of one of these subdivisions.

It is the consensus of opinion of the Committee that the work should consist of a thorough canvass of the different methods in practice by the railroads of the country, and after such a canvass to recommend certain methods as being the best adapted to meet the different requirements.

In submitting this report we wish to state that the first two Sub-Committees have not made such a canvass, owing largely to the lack of the necessary time to devote to the matter, and the reports from these Sub-Committees are more in the nature of individual papers and are presented here as such for the discussion of the Association. The third Sub-Committee has gathered a certain amount of information from a list of questions sent to two hundred railway companies, the result of which is given in their report.

THE SOURCE OF SUPPLY OF WATER FOR AMERICAN RAILWAYS.

Water is as absolute a necessity on the railway as steel rails, bridges and fuel. It may be bad water, it may have to be hauled hundreds of miles, and it may be expensive, but it must be furnished.

After providing the water, the problem is presented to find good boiler water and next to supply it cheaply.

The sources may be divided into two general classes, viz., surface and subterranean.

The questions of quantity and quality are easily determined in the former, but the real troubles of the Water Service man begin when he approaches the second division. There are, however, a few problems that will bear mention in the easier part of the subject; streams will get muddy, reservoirs will silt up, drouth will affect them and evaporation exhaust them. The best method of overcoming these troubles is worthy of discussion, and the experience of members is requested, both as to the feasibility and the cost of the following:

Mechanical filtration;
Settling tanks;
Use of coagulants;
Cleaning reservoirs.

From subterranean sources water is generally taken by means of wells, and these may be divided into shallow and deep, the former drawing its supply from the immediate surface, while the latter, as a rule, goes deep enough to draw from some water-bearing strata that is practically a reservoir. From the nature of the sources, the former is affected by the amount of the rainfall each season, while the latter, on the contrary, is not dependent on any one year's rains. The shallow well may be either dug, bored or driven, the particular kind being determined by the depth necessary, the amount of water to be had, and by the character of material in which it is located. It is, on account of its cheapness, the usual source of supply whenever the rains are sufficiently regular and ample. In the so-called arid region, however, the deep well is a necessity. This may be only two or three hundred feet deep, or it may go a thousand. The drilling is expensive and many holes are put down that are failures, either by yielding no water or because the water found is unfit for boiler use.

Knowledge relative to underground supplies of water can only come by the closest study and attention. In the case of shallow wells, surface indications, configuration of the surrounding country, intelligent interpretation of the results of trial wells, all taken together, will be found valuable aids in determining where to look for water. Deep wells are simpler in that only by trial bores can we determine what is to be found. The keeping of careful records of all deep wells is an absolute necessity for economy in providing water from this source, and these records should show not only the different strata encountered, but the character and amount of water found in each strata. Such records will enable a definite decision to be made as to the possibility of obtaining water at intermediate stations and enable approximate costs to be determined. It will also give an idea as to when to stop drilling when outside the limits of developed water, although in this latter case the depths will be indeterminate, owing to possible folds and dips of the water-bearing strata. In a recent case on a Western road, owing to increase in business, water was wanted at a cer-

tain station. Estimates were prepared on piping it from a source some miles distant, and on drilling a well. From the records kept of other wells miles distant, the depth was estimated and the amount and character of water predicted, and on this estimate the well was put down. The water was found slightly nearer the surface than was estimated. If the usual uncertainties in the way of well-boring had existed, there would have been no question about taking the pipe line.

Outside the problems connected with the finding of underground water are those of boring and casing, such as the kind of plant, the size of well, the variety of casing to use, the form of starting piece, including perforations. In shallow wells a much cheaper casing may be used than in deep wells. Sometimes it is double and sometimes single, sometimes black and sometimes galvanized. The size should be large enough to accommodate the pump, say from eight to ten inches diameter for the smallest to two feet for a large size. The gauge of iron to be used varies from No. 14 to No. 20. When double casing is used and when it may be necessary to cut off upper flows of water on account of quality, black iron seems best, as it soon rusts between the casing and makes a water-tight casing, while galvanized iron resists this action for a longer time and makes it impossible to keep out the upper water.

Ordinary water in shallow wells is found in either sand or gravel, and to allow the water to enter the casing, perforations are made in the bottom length, known as the starting piece. Frequently the sand is so fine that it will work through the ordinary perforations, and then special devices are needed. It is essential that this sand be excluded, for the reason that it not only rapidly cuts out the pump leathers, but will eventually fill the casing and cut off the supply of water.

As an extreme case in this direction, wells are sometimes sunk to the water-bearing stratum in the ordinary way. A new casing with the bottom length perforated and then wrapped with brass netting of the very finest mesh procurable—practically a wire cloth—and with protection pieces soldered on the outside, has been placed within the outer casing, and the latter pulled out.

So-called driven wells are practically the same as drilled wells, except that the pipe is provided with a cast-iron or steel point and then driven to the requisite depth in place of having the material bored out and the pipe then forced down by weights as in the ordinary method.

In deep-well work, lap-welded tubing is used and the tools and outfit are heavier and capable of going through any material. In certain alluvial valleys, however, wells have been sunk a thousand feet by what is known as the hydraulic process, which consists in forcing water under pressure through a smaller pipe in the inside of the outer casing, and this bores the well and carries the material up to the top and deposits it when the water overflows the top of the pipes. The main casing is then forced down as in ordinary drilling. Where putting down a well without knowledge as to the depth necessary, it is usual to start with large size casing, and when this strikes a stratum where it will not go deeper to place a smaller casing inside and to go deeper with that.

Quality of water as affected by the source will now be considered. There are no known rules governing this. In artificial ponds, water brought from streams having practically no impurities, coming directly from melting snows, has been found to be very poor for locomotive use by causing foaming. Why this is so is unknown, but possibly on account of organic matter in the reservoir. In reservoirs in the arid regions, the stored water is apt to be bad on account of the salts picked up from the soil by the rain during time of flood. Evaporation tends to increase this difficulty, and as the supply gets low the water frequently gets absolutely unfit to use in a country where ordinary bad water is considered admissible. In certain streams in the West the water is so full of salts that it cannot be used and yet good water may be found close underneath. One case is known where for many miles along a stream of this kind there is a subterranean supply of excellent water about 60 feet below the surface. The contrary also holds true. In one case where good locomotive water was found in a stream, when clear borings were made on the bank of the river to endeavor to obtain the same supply without the mud that came after rain, the water was of entirely different quality and unfit for use. A like result was found with a boring in the bed of the river itself, and this at a depth of only 20 feet.

In the case of deep wells the water found in like strata is usually of like quality, but, as a rule, the deeper the stratum the poorer the quality.

Respectfully submitted,

W. B. Storey, Jr.,
H. C. Draper,
Sub-Committee.

REPORT OF SUB-COMMITTEE ON METHOD OF PUMPING AND SUPPLY.

(a) Direct from tanks;
(b) Through standpipes;
(c) Through track tanks;
(d) Cost of pumping;
(e) City waterworks supplies;
(f) Pumping machinery, boilers, etc.

(a) Water taken direct from a tank standing close to track, through a goose-neck and spout, will probably always be a favorite way when first cost is the principal consideration. Objections to it, however, are many. Among these are: The height must be approximately uniform, whereas greater height than this arrangement permits is often desirable, for better head, giving quicker service, for fire protection, etc.; position of tank is restricted, whereas choice of position is often desirable for various reasons —more favorable ground, better view around curves or from a highway crossing, less liability to injury from a collision, fire, etc.; much greater difficulty to protect from frost; spouts not being properly put up out of the way, often hanging low enough to strike men on top of cars, and many accidents of this kind have happened; waste of water when spout is put up, causing slop in summer and ice in winter, etc.

(b) Modern conditions on first-class roads call for ten-inch standpipes with flexible joint, giving some four feet vertical movement to end of

spout. Such a standpipe, with 100 feet of ten-inch pipe between it and bottom of tank, with masonry-pit drainage and sawdust frost protection in wooden box under tank on twenty-foot posts, will add to cost of low tank and spout some $700, other things being equal. With this against it, pretty much everything else is in its favor—better head, clearer view, freedom from danger of serious damage from accident of foundation being knocked from under tank, less liability of accident to trainmen, less slop and ice on track, etc.

(c) Track tanks—an expensive luxury where not especially needed—become pretty nearly a necessity on a long road, crowded with heavy fast trains, saving as they do time of stops for water. From ten to twenty-five per cent as much water as goes into the tank of engine is pushed out by spout and wasted, depending upon form of spout and speed of train. They are hard to heat satisfactorily; it must ordinarily be done with steam, and generally with lack of uniformity along the tank. The cost of heating plant will vary from $1,500 (where the boiler in pump-house is large enough to furnish the steam required), to twice as much or more (where an independent plant has to be put up); and the operating expenses will vary from the mere cost of additional coal to supplies and pay-roll for additional plant. They are hard to maintain; ordinary paints last less than one season under the water. An asphalt coating, put on hot during hot summer weather, is probably the best treatment for them.

(d) The cost of pumping water for railroad use probably varies more than for any other purpose, as the conditions are so infinitely various, as in amount of water needed, kind of power available, quantity and quality of supply, etc., so that any kind of a general estimate of cost is futile; it will continue to vary from almost nothing—with water rams and wind mills under favorable conditions, pumps on natural gas lines, etc.—to the cost of pumping by hand. The cost of pumping water by steam into a railroad tank will also greatly vary, depending upon many things—the quantity to be pumped, the height to be lifted, the cost of coal or other fuel at the pump-house, the duty of the pump, the pay-roll at the pump-house, etc.

The duty of, or effective work that can be done by, any steam pumping engine, is expressed by the ratio of the product in foot pounds of the weight of water into the height it is lifted, to one hundred pounds of the coal burned to lift the water. Fanning gives the weight of coal required to pump one million gallons of water one hundred feet high in twenty-four hours at different duties, as follows:

At	100	million	duty.....	834	pounds.
"	50	"	"	1,668	"
"	20	"	"	4,170	"

or the amount of coal is an inverse multiple of the duty. It is easy enough to get pumping engines that will pump this amount at even a higher duty than this, but they must work continuously for many hours at a time, and the coal must all be burned for making steam to be used only for pumping; that is, neither steam nor coal must be wasted. With run-of-

mine coal at prices prevailing in the vicinity of Chicago, this should mean something like one-quarter cent per 1,000 gallons for cost of water in the tank, counting all expenses in the pump-house. It is safe to say, however, that the conditions will seldom, if ever, be such in any railroad pumping station that this figure can be hoped for, and that where relatively small amounts are needed the economies will have to be looked for elsewhere, as, for instance, in the pay-roll. It is frequently possible, where trains run to suit, to use one man to pump at two or even three stations, by having pump and storage capacity large enough to furnish and hold the supply needed during the time available between trains, provided also the supply is free enough for pump to run at full capacity. Railroad steam supplies will vary in cost from about one cent to frequently five cents and ten cents, and sometimes fifty cents or more, per 1,000 gallons.

The Association of Railway Superintendents of Bridges and Buildings have a committee report in their proceedings of the ninth annual convention (1899) on the "Best and Most Economical Plant for Pumping Water for Water Stations," in which they attempt to compare the cost of pumping by steam and gasoline. The conclusion they reach is that gasoline at ten cents per gallon is equivalent in value, as a fuel, to coal at sixty cents per ton (of course, this does not consider duty of pump), and that at these relative values for fuel the only economy in favor of gasoline is saving in wages of pumper. Many gasoline engines are run by section foremen, station agents or other men whose wages can be charged to something else, and if these men can learn to properly run the gasoline engine and will take proper interest in it, a marked economy may often be effected.

(e) Supply from city waterworks, when water is good and supply is sufficient and reliable and price is satisfactory, is a very comfortable solution. It is generally required to make connection to mains with a pipe not more than four inches in diameter, so that a tank is necessary exactly the same as for any other method of supply, and the size of this tank should be regulated by number of engines likely to want water at one time.

(f) The best pumping plant is none at all. If a gravity supply is available at reasonable cost, it is hard to beat. When the flowing water is too low to reach the tank, it may perhaps still be utilized as a water power, either through a wheel and pump or hydraulic rams. Rams are on the market with a capacity ranging up to 300 gallons per hour, which can be delivered from 20 feet to 120 feet above the ram, according to head available, the head required being approximately one-seventh of the height to be raised, and the amount delivered being approximately one-twelfth of the supply to the ram. They can be arranged in batteries of any number of rams, working into a common discharge pipe, but working entirely independently of each other. Like most other good things, however, their application is limited.

In regions where the wind blows often and hard enough, windmills furnish an economical solution for stations within their capacity and with storage sufficient to carry them over the calms. Wheels are common up to thirty feet diameter, having eight horsepower with wind at eighteen miles per hour, and pumping 6,000 to 18,000 gallons per hour, according

to wind and lift. Unfortunately, it is also quite common for the section gang to be called upon to run the pump by hand when the wind doesn't blow.

Steam-pumping plants should be carefully designed according to conditions at each particular station. A station requiring a large amount of water should have a high duty engine and high enough priced engineer to take care of it, especially where cost of fuel is large; but these will generally be considered unwarranted refinements, where the amount of water is small and fuel is cheap. Then the greater economy will often be had by locating the pump somewhere so that in some way the time of the pumper can be divided up with some other work. All pump-houses should be located whenever possible with a view to getting the fuel to them as cheaply as possible. Unnecessary shoveling and hauling by team adds rapidly on cost of fuel.

The market is full of pumps and pumping machinery, and the choice of same should depend chiefly upon the price warranted by the special conditions at the particular point where it is to be used. The market is also full of gasoline engines, and guarantees from their makers. They do good work when properly designed and taken care of, and are often the most desirable choice. Too much dependence, however, must not be placed upon claims of makers that they do not need the attention that some other machinery does. Any engine will run for a while with the engineer absent if a supply of power is available from any kind of a reservoir; but most rapidly-moving and delicately constructed machines work much better the more closely they are looked after.

As a general proposition, it is safe to say that no gasoline engine should be depended upon that does not have intelligent supervision at least once every six hours, when at least one hour should be given to taking proper care of it.

Where it is desired to transmit power to a pump situated at a distance from the source of supply, compressed air furnishes a good means. Edward A. Rix gives a valuable article in the Journal of the Association of Engineering Societies for October, 1900, on this subject. He evidently had especially in mind pumping from mines, but its usefulness is not by any means so restricted, and at least one form of it mentioned by him—the air-lift pump—is used to great advantage in many railroad plants. When there are, for example, a number of wells situated at a considerable distance from the pump-house, compressed air from a reservoir in it can be led in a suitable pipe to the bottom of each and the water be forced by it to a common tank. This method is fully described in publications of the leading makers of air-compressing machinery. It is especially valuable where the water carries quicksand, which, though death to any other pump, does not interfere with this in the least; also, in wells too deep for easy application of other pumps. With a high-grade air compressor results can be had by this method that compare very favorably with other methods of pumping.

Boilers should be selected that are designed for the special work they have to do. It is generally not economy to utilize an old locomotive boiler

taken from the scrap heap and repaired at a price pretty nearly what a new and suitable boiler could be had for, although we fancy many will recognize that as a tolerably common practice. It is sometimes desirable, however, where the pumper is utilized for other work that takes him away from the pump house for frequent short periods, to have a boiler large enough to take care of itself safely until his return. While the actual cost of the steam for such a boiler will probably be somewhat greater, the difference may be made up in the time of the man.

In the natural gas regions, often gas from certain wells has a pressure greater than is desirable, and this excess pressure is often utilized in running engines, the gas, having done its work, being discharged at the reduced pressure into a pipe line beyond the engine. This arrangement makes an ideal power for running a pump, but unfortunately we don't all tap the natural gas belt.

Many schemes have been devised from time to time to meet certain conditions, of which the submerged plant of Mr. McHenry is an ingenious instance, and several kinds of steam syphons, etc., but their usefulness is in most cases at best limited to the special conditions for which they were designed, but as at most water stations special conditions will always obtain, perhaps but little more than this can be said of any other kind of machinery.

Respectfully submitted,

SAMUEL ROCKWELL,
O. D. RICHARDS,
Sub-Committee.

REPORT OF SUB-COMMITTEE ON CHARACTER OF WATER.

Circulars embodying the following questions were sent to 200 railway companies:

To question 1. Name of road? Seventy-one replies received.

To question 2. What is the general character of water used on your road for locomotives and stationary engines?

49 report fair to good water.
15 " fairly good to bad.
5 " bad.
2 " very bad.

To question 3. If bad, is it susceptible to treatment for removal of scale-forming impurities?

30 make no reply (include all good water roads).
23 reply yes.
1 " partly so; thinks distilling would do.
1 " some of it, yes; experimenting.
6 " think so; but nothing tried.
6 " no.
4 " partially.

To question 4. Are you using any boiler compounds?

11 make no reply.
30 answer no (all good water roads).
3 " not at present, or not now.
16 " use soda ash in tenders.
4 " using soda ash and patented boiler compounds.
1 " using soda ash and lime.
2 " to a limited extent.
1 " experimented; no results.
2 " experimenting with Rubra oil.
1 " yes.

To question 5. If so, are they successful?

41 make no reply.
8 answer yes.
13 " partially so.
6 " no.
1 " yes, except with alkali waters.
1 " undetermined.
1 " doubtful.

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71

To question 6. Cost per 1,000 gallons for treatment?

1, who abandoned it, reports 5 to 50 cents.
7 report no record.
47 make no reply.
9 reply, giving individual figures as 4c, 3c, ¼c to 2c, 1-3c, 4 to 5c, 6c, 1c, ⅜c, ¾c.
2 " ½c.
2 " 2c.
1 " 6.65c for soda ash and a patent boiler compound, and 2.9c for soda ash alone.
1 " various.
1 " very slight.

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To question 7. Are you using any mechanical plant for treatment by Clarke process?

22 make no reply.
40 answer no.
1 reports Wefugo plant, 300,000 gallons' capacity. No remarks as to success. Treatment costs 10½c per 1,000 gallons.
1 " Wefugo plant, 100,000 gallons' capacity. Successful. Plant cost $3,000. Treatment, 2.28c per 1,000 gallons.
1 " mechanical plant at roadside tanks for mixing tri-sodium phosphate. Daily capacity, 100,000 to 200,000 gallons. Cost, $10 to $20 each. Treatment costs 2.5c to 36.6c per 1,000 gallons.

1 uses secondary tank for chemical treatment. Daily capacity, 40,000 gallons. Plant cost $1,000. Treatment, 1½c to 3c per 1,000 gallons.

1 reports 3 Fewell Filter Company plants, 60,000, 183,000 and 188,000 gallons' daily capacity. Cost, $1,500, $2,700 and $2,600, respectively. Treatment, 6c, with bicarbonate of soda, and 1 to 1½c with lime (presumably Clarke's process).

1 reports 1 plant for Clarke's process, 45,000 gallons' daily capacity. Cost, $2,400. Treatment costs 1c. Very successful.

2 expect to install a plant soon.

1 reports investigating; no results yet.

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Questions 8, 9 and 10, with reference to capacity, cost of installing and cost of treatment, are included in replies to No. 7.

To question 11. Do you consider that water should be treated before pumping into supply tank, or after?

24 reply before.
1 " after.
37 make no reply.
3 (who use soda ash) reply "in the tenders."
1 replies either way.
5 reply no experience, or not treated.

71

To question 12. If you treat water in tank, what arrangement have you for removal of deposits in the bottom, and preventing any of it being carried into locomotive tenders when valve is opened?

62 make no reply. (Includes all the good water roads.)
1 reply not considered yet.
2 " treat in tenders.
1 " water not treated.
2 " raise valve 18 inches above bottom of tub.
1 " uses a cylinder shield, 18 inches high, around the valve.
1 " uses special drain pipe.
1 " raise valve 16 inches above bottom and has 3-inch drain pipe.

To question 13. How often do you clean out tanks?

48 made no reply.
1 reply 60 days.
8 " six months.
1 " three to six months.
1 " monthly to two weeks.
2 " no record.
2 " six to twelve months.
1 " when mud or other deposit approaches top of shield around valve.
1 " secondary tanks, once or twice per month.
2 " when deposit makes it necessary.

1 " ten days during high water and two months in winter. Takes supply from Mississippi and Missouri Rivers.
2 " seldom necessary.

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Respectfully submitted,

G. H. WEBSTER,
Sub-Committee.

It is to be regretted that the list of questions sent out by the Sub-Committee on "Character of Water" were not more generally answered. Of the 200 railway companies to whom these questions were submitted, but 71 replied. Of these, 49 reported that they had good water, leaving but 22 roads heard from that reported the water all the way from "fairly good" to "very bad."

Thirty of the 71 roads heard from are using, or have at some time used, soda ash, or some kind of boiler compound; of these 30, but 8 report such use as being successful, while 6 report such use as not successful, and the remaining 16 report such use as being only partially successful, or in doubt.

The following letter from the Master Mechanic of the Green Bay & Western Railroad Company treats the subject of boiler scale in a very interesting manner; and the conclusions reached being quite at variance with the general ideas upon the subject, the Committee has decided to include the letter in this report.

GREEN BAY & WESTERN RAILROAD CO.,

MASTER MECHANIC'S OFFICE,
Green Bay, Wis., Feb. 18, 1901.

To L. C. Fritch, Secretary American Railway Engineering and Maintenance-of-Way Association:

The inclosed request, with circular attached—subject, "Water Service"—has been referred to me by Mr. J. A. Jordan, General Manager of our road. As per his request, we have filled out the blank form and added an appendix, stating more fully our experience with water supply for locomotives.

Our water supply along our line is gotten principally from artesian well—one 630 feet deep, one 395 feet, one 255 feet, one 165 feet, one 112 feet, two 60 feet and one 58 feet; one of surface water, another of surface and marsh water, considered the best on the road, two from creeks and two from small rivers (considered good water), one mineral and sand rock (considered the best water in Wisconsin for steam purposes), 255 feet deep. We have never had water from any of the wells analyzed.

In our case, however, past experience and reputation do not speak well for surface water running over the surface of granite. We run flues in our boilers from 14 to 34 months, thickness of scale forming from 1-16 to 5-16 of an inch. We experience no such percentage of increase in fuel consumption when boiler is scaled as is usually given. If you will pardon the statement, I will say that I am surprised how often reference is made to that "ancient adage" about scale reducing the efficiency and capacity of a boiler. The figures often quoted, which you will find in all recent publications appertaining to boiler scale, namely, a scale of 1-16-inch in thickness, requires the extra expenditure of 15 per cent more

fuel. The ratio increases as the scale thickens; thus when it is ¼-inch thick, 60 per cent more fuel is needed; ½-inch thick, 150 per cent more, and so on. This is based on the hazy authority of a paper read by Dr. J. C. Rodgers, some years ago, before the American Association for the Advancement of Science. The paper gives little more than the bare statement of results.

We have made some very exhaustive experiments with 3-foot sections of 2-inch locomotive tubing, varying in scale from 1-64-inch to ⅜-inch thickness. The tests have been made after practical lines, special care being taken as to temperatures of water, etc., temperatures being taken with Centigrade thermometer, Fahrenheit not being suitable for tests made. In a great many tests which we have made in the past six months we have demonstrated without a doubt, and it has been shown repeatedly, that scale has very little effect on the efficiency or capacity of a boiler.

It is a common experience for locomotives to come into shops with a space between the tubes choked solid with scale, but without any deterioration either in capacity or fuel economy having been noticed. The principal and practical objection to scale deposits is the danger of burning. It is shown, on the other hand, that a coating of soot carries with it little or no danger, but causes a great dropping off in both efficiency and capacity.

Another thing which would contribute largely toward the deterioration of efficiency and capacity is the neglect, after a locomotive has been in service 14 months or more, and which we consider is more vital than boiler scale, is the inattention that a locomotive gets as to cylinder packing, valves blowing, choked nozzles and double-flanged tires, all representing an increased fuel consumption in a greater proportion than scale in the boiler.

We are very much interested in the subject of feed water, and certainly not partial to boiler compounds and purges, which have been tried for years and abandoned by our best engineers as ineffectual, injurious and in very many cases positively dangerous.

Of course it goes without saying that we wash out boilers frequently and see that the work is properly done, and our experience has been that the best substitute for pure water and boiler compounds is to remove the flues, mechanically clean them in shop and replace them at the following cost: To open front end and remove all pipes, including dry-pipe preparatory to doing flue work, $2.30; removing 200 flues, at 3¼ cents, $6.50; replacing same at 5 cents, $10; regrinding all joints and putting pipes back into engines, $4. In the price of removing pipes and replacing them, the removing and replacing of netting is taken into account, all our engines being equipped with extension front ends. Total cost, $22.80. Nine tons of coal at $2.75 represents the trifling sum that is required to remove the boiler scale. In the above calculation it is understood that the loss of the engine's service while in shops is not taken into account.

In conclusion, will say that scale has very little effect upon the efficiency and capacity of a boiler.

(Signed.) W. P. RAIDLER,
Master Mechanic.

Respectfully submitted,

W. E. DAUCHY, *Chairman;*
D. WILLARD, *Vice-Chairman;*
H. C. DRAPER;
O. D. RICHARDS;
W. B. STOREY, JR.;
G. H. WEBSTER;
SAMUEL ROCKWELL;
Committee.

Mr. W. E. Dauchy (Chicago, Rock Island & Pacific):—I have very little to say on the subject. I wish to state that our Committee has not been able to hold any meetings at which there was a full attendance. I do not mean to say we have made no effort to hold meetings, but the members of the Committee are scattered over a wide territory and it has seemed impossible to get more than two together at a time. I wish to call attention to a paragraph in the opening of our report. It is as follows: "It is the consensus of opinion of the Committee that the work should consist of a thorough canvass of the different methods in practice by the different railroads of the country, and after such a canvass to recommend certain methods as being the best adapted to meet the different requirements."

I wish to say that, as far as the reports of the first two subcommittees are concerned, they have not been made on the basis of this idea as to how the work shall be carried out, but they are merely presented here more in the nature of individual papers for the purpose of discussion and bringing the matter before the Association, than as being the consensus of opinion of the Committee. The third subcommittee on the subject of the character of water has made some effort to get together some information with reference to the practice as to the use of boiler compounds, methods of treating water, etc., and the result of that investigation is embodied in this report.

I also wish to call attention to a letter from the master mechanic of the Green Bay & Western Railway, which is embodied in this report, giving the result of some experiments which that company has made with reference to the incrustation of boilers. The Committee thought the letter was of sufficient importance to introduce it in this report, as it gives some results that are at variance with the general opinion on that subject.

Mr. D. D. Carothers (Baltimore & Ohio Southwestern):—The letter referred to from the master mechanic is at great variance with the experience of the railroads with which I am acquainted. The methods of making the test are not set forth clearly in this letter. It is a well-known fact that there is a great difference in substance as to the resistance and conductivity of heat. In our territory there is no question but what the scale that is formed on the flues in a boiler requires a consumption

of a greater amount of fuel, and there may be something peculiar in the scale formed on that road. There is nothing here to indicate what that may be.

Mr. W. E. Dauchy:—In this letter the master mechanic states that they have had no analyses made of any of the water that they used. I think that point would be an interesting one if we knew the character of that water.

Mr. A. S. Markley (Chicago & Eastern Illinois):—We have installed two filtering plants. In both cases, after using the water, we found it was very muddy and a great deal of mud accumulated in the boiler around the flue, necessitating washing out the boiler nearly every trip in order to keep it from cracking. We installed a filter at both these places at a cost of $2,800 apiece. Each of these would filter 8,000 gallons, and they have been ample for our demand. At Thebes we have a hotel which is also supplied with the water, and it is used for everything connected with the company's service with good results. There is no alkali in the water. In a test made recently as to the cost of filtering the water, the filter was in service 99 days, beginning with November 10. In that time they expended $33.42 for potash of alum, which is the only ingredient used in filtering the water. Of course, you understand that the water is pumped through quartz in order to reach the filter. The alum is supposed to gather up the solid and collect it together, and deposit it on top of the gravel. About every two days they are washed out, taking 8,000 gallons of water to wash the filter. On a basis of 25,000 gallons a day, which we assume is a fair quantity to say that they use, it cost 1.35 cents per thousand gallons, or .65 cent per gallon for alum. So far we have had good results with them, and I believe it is the intention, from what I have gathered by correspondence with Mr. Dawley, that the company still intends to put up plants at other places. As for pumping water, we use a great many gasoline engines.

The President:—Mr. Sullivan, you have had experience in the matter of both surface and artesian water in various parts of the country. Can you give us some information?

Mr. A. W. Sullivan (Illinois Central):—I regret that I have not had an opportunity of looking at this report of the Committee on Water Service until this morning. I do not know

that I can say anything at this time with reference to the report of the Committee and its subject-matter. The quality of the water and the quality of the fuel are two things that are of the greatest importance in operating service. The water problem as it has developed in Illinois within my experience has not been so much the quality of the water as to get any water at all. It is quantity rather than quality, and for that reason the part of the Committee's report which relates to the purification, softening, filtering, etc., of feed water, in that it may make available many sources of supply now unused, is one of more than ordinary importance.

Mr. F. A. Bryan (Michigan Central) :—Mr. Markley spoke of the application of gasoline engines. I have not exactly recommended but suggested the use at a number of places of electric motors. We have them at several places for our elevators and they work very successfully. Manufacturers and others engaged in commercial pursuits have applied the motor to a pump very successfully. I have in mind two or three small plants that work very successfully, requiring scarcely any attendance, simply inspection of the motor. I would like to ask if any of the railroads have adopted the motor at all.

Mr. Markley :—What does it cost a gallon to pump with the motor?

Mr. Bryan :—I have not made any investigation as to the cost. But the original equipment costs a little more for the pump and electric motor—about the same as a steam engine. Our experience with the motor for elevator purposes has been that it is decidedly cheaper than the gasoline engine.

Mr. Carothers :—I would ask the gentleman from what source he obtains his power to operate the motor. It must require either steam, water or gasoline, something of the sort, to generate the power. While I am on the floor I would ask Mr. Markley the character of the gravel they use for their filter. In our territory the gravel is composed of limestone largely, so that water that is filtered through it becomes highly impregnated with lime and magnesia, making it unsuitable for boiler purposes.

Mr. Markley :—In answer to Mr. Carothers I will say that the quartz or gravel is furnished by the filter company, and it is specially selected for that purpose.

Mr. Bryan:—I refer, of course, to water stations in towns of 5,000 or over. There is hardly a town of 5,000 inhabitants but what has a power plant that runs 24 hours a day.

The President:—I presume the roads in the East have less trouble in the matter of water than we do in the West. As Mr. Sullivan states, the question of quantity is a rather serious one. Our experience on the Illinois Central with artesian wells has been very unsatisfactory. Regarding the quality of the water we obtain from them, hardly any two wells have shown the same chemical analysis or would be benefited by the same treatment. Our policy now is that wherever it is possible to do so to construct reservoirs, even if we have to incur a large expense—although we only have one or two such reservoirs constructed at present. It appears to me that ultimately—particularly throughout the West—some means will have to be adopted to enable us to use a poorer quality of water. The improved drainage over the cultivated country now causes the water to run off more rapidly than it did in years past, and the demands of the roads for water on account of the greater tonnage hauled is increasing daily, and from year to year, and it is becoming a serious question.

Mr. Markley:—On our line, south of Danville, we have tried every means to obtain water out of wells, boring down as deeply as practical, but have found it impossible to do so. We have since adopted the reservoir system in that section, with the exception of one place. We had repeatedly been asked to clean out a well at an old abandoned mill about three-fourths of a mile from our track. Finally we concluded to make a trial, and in cleaning out the well and boring about twenty feet deeper, the workmen had hardly sufficient time to get out of it to avoid being drowned. We have also had experience with water witches, and in one case where we employed two men for this purpose, unknown to each other, it was found they had selected a place within ten feet of each other. At the point selected, we bored down 87 feet, and since that time we have never been able to exhaust the supply.

Mr. A. L. Buck (Canadian Pacific Railway):—I do not believe in water witches, from the experience I have had in that line. In the Assinnaboine territory there seems to be an abundant

water supply. At some points water may be found within 12 feet, and in other directions it is impossible to find it within any reasonable depth. We drilled three wells to a depth of about 300 feet and still got no water, and I would like to get, in that connection, the opinions of members as to whether water at a depth of 300 feet is suitable for boiler purposes without treatment. The government drilled a well 1,400 feet deep about fifty miles south of us, but did not strike anything; however, they were drilling for oil. At one time we tried a water witch, and after spending quite a time he claimed to have located water, undoubtedly, and after drilling 300 feet we found no water. We intend to go deeper, however, but are under the impression that the water is not fit for boiler purposes at such depth. I remember seeing the water witch locate water in a field over a solid ledge, but the drill could not find it.

The President:—As our time is short, I would suggest that any further discussion on this report be communicated in writing to the Secretary. Mr. Dauchy, have you anything further to say before closing the discussion?

Mr. Dauchy:—I do not suppose that there is a question which comes before this Association for discussion upon which there is a greater variety of opinion than this question of water supply and the character of the water. It is due to the fact that the quantity and quality of water are such varying quantities in different parts of the country that the question presents itself in various degrees of importance, from the simple problem of economical pumping, to the more complex one of obtaining water where very little is to be had, or of changing the character of bad water so as to make it serviceable, and our opinion is based upon our individual experience in meeting the various phases of the question. Mr. Wallace speaks of the question of reservoirs. That is all right in a country where the rainfall is plentiful, but my experience has been that where water is scarce in the ground looking for it above the ground is equally futile. I have one case in particular in mind. About six years ago I constructed a reservoir. The drainage area leading to the reservoir amounted to something like ten square miles. We thought, of course, we would have water there, and we had had from that stream previously to that very large floods. We constructed a reservoir, and

for the four following years I do not think there was sufficient flow into that reservoir but that a 6-inch pipe would carry it all away. From that time to this we have not had water enough in the reservoir to pump from. That is a mere illustration of the different views one gets upon this subject, comparing one point of the country with another.

The President:—The next in order is the report of the Committee on Organization, of which Mr. Carothers is chairman.

REPORT OF COMMITTEE No. XII, ON UNIFORM RULES, ORGANIZATION, ETC.

To the Members of the American Railway Engineering and Maintenance-of-Way Association:

At this time your Committee is only able to report progress. The fact that the Committee is composed of members situated in distant parts of the country has made it very difficult to obtain a quorum at any of our meetings, and the nature of the work under consideration by this Committee makes it very difficult to accomplish anything except by having the members of the Committee present, as it is almost impossible to reconcile the various organizations now in existence among the different railroads.

Valuable information has been obtained by correspondence since the last annual meeting; although the Committee has not been able to arrive at a definite conclusion as to a report that can be recommended for final action of the Association. We therefore ask for additional time in which to perfect our report.

The Committee, however, will be greatly pleased to have some discussion on the various subjects it has in hand.

The first thing that confronts us is a definition for a Maintenance-of-Way Department. We have had several suggested, which are herewith submitted:

First—The Maintenance-of-Way Department is a subdivision of the Operating Department, in charge of the maintenance of right-of-way, tracks and structures.

Second—The Maintenance-of-Way Department is a subdivision of the Engineering or Operating Department, in charge of maintenance-of-way, tracks and structures.

Third—The Maintenance-of-Way Department is a subdivision of the Operating Department, in charge of the care of right-of-way and maintenance of tracks and structures.

In considering the work before the Committee, we have thought it proper to consider, first, a proper organization of the Maintenance-of-Way Department, then ultimately to enter upon the discussion of the other subjects assigned the Committee.

There are two types of organization—one in which the Division Su-

perintendent is in charge of the Maintenance-of-Way, as well as other Operating Departments on his division; and the other, in which the Division Engineer or some officer equivalent reports direct to the Chief Engineer or head of the department.

Information received from forty-two of the principal railroads, representing a total mileage of 95,863 miles, regarding the type of their organization, reveals the following facts:

Twenty-three of these railroads, with a mileage of 55,634 miles, have an organization in which the Superintendent has full charge of the Maintenance-of-Way on his division.

Nineteen of these railroads, with a mileage of 40,229 miles, have an organization in which the Chief Engineer, or officer bearing other title, but performing similar duties, is in full charge of all engineering and maintenance-of-way matters—the Engineers of Maintenance-of-Way and Division Engineers reporting direct to the Chief Engineer.

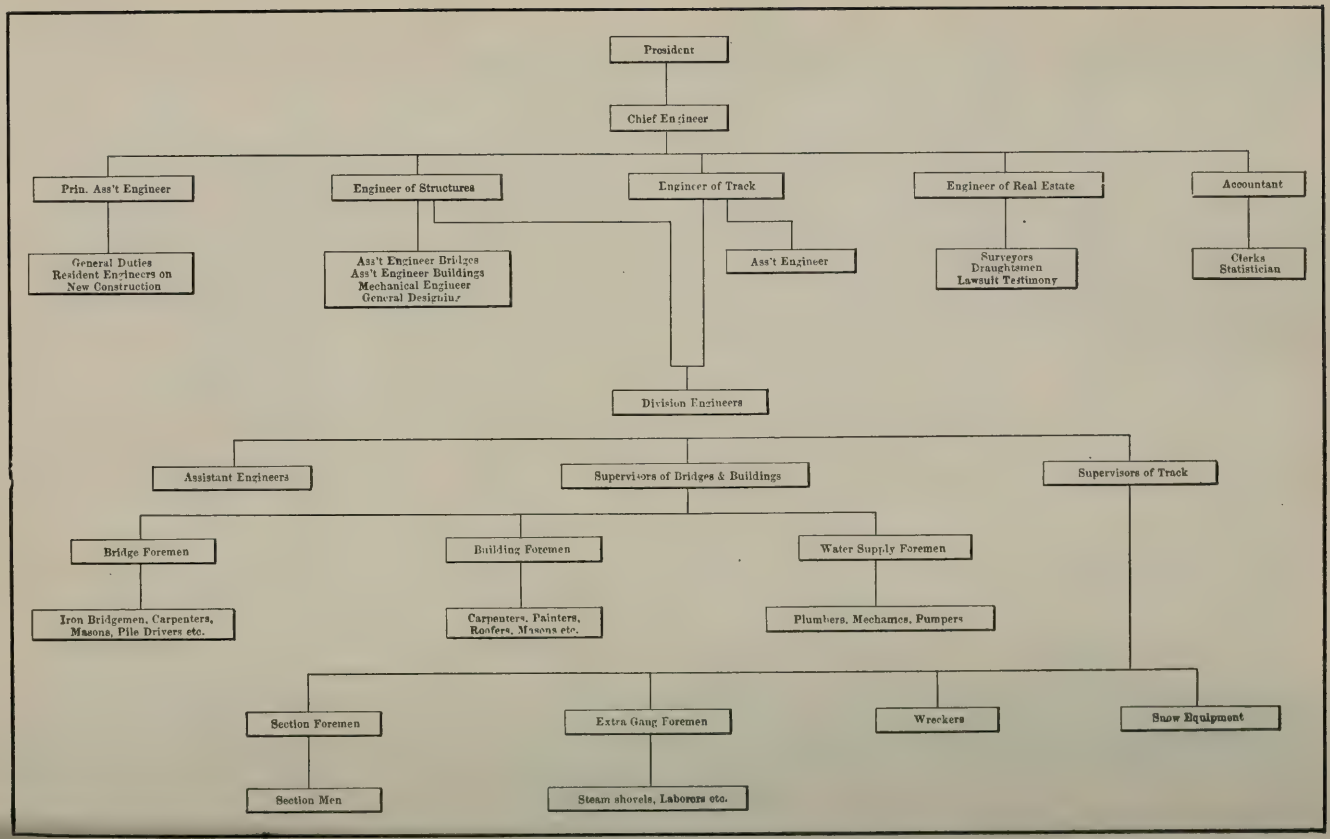
It will thus be seen that the organization in which the Superintendent is in full charge of all division matters predominates.

Several diagrams of proper organizations of the Maintenance-of-Way Department have been submitted and considered by the Committee, but no definite action has been taken. We hope, therefore, the Association will give us the benefit of a full discussion of the organizations as set forth in these diagrams. In this way we hope to be enlightened, so that before another meeting of the Association we may be able to present an organization that will be satisfactory. When this has been done, it will greatly aid in the other work of the Committee.

For convenience, the diagrams will be Nos. 1, 2, 3 and 4. Nos. 1, 2 and 3 are organizations now actually in existence. No. 4 is submitted as an ideal organization, and more elaborate than the others. The person submitting this organization desired to make it of sufficient scope to cover the largest line of railroad. This could be reduced until there might be only two important officers—the Chief Engineer and the Superintendent, depending entirely upon the mileage of the railroad.

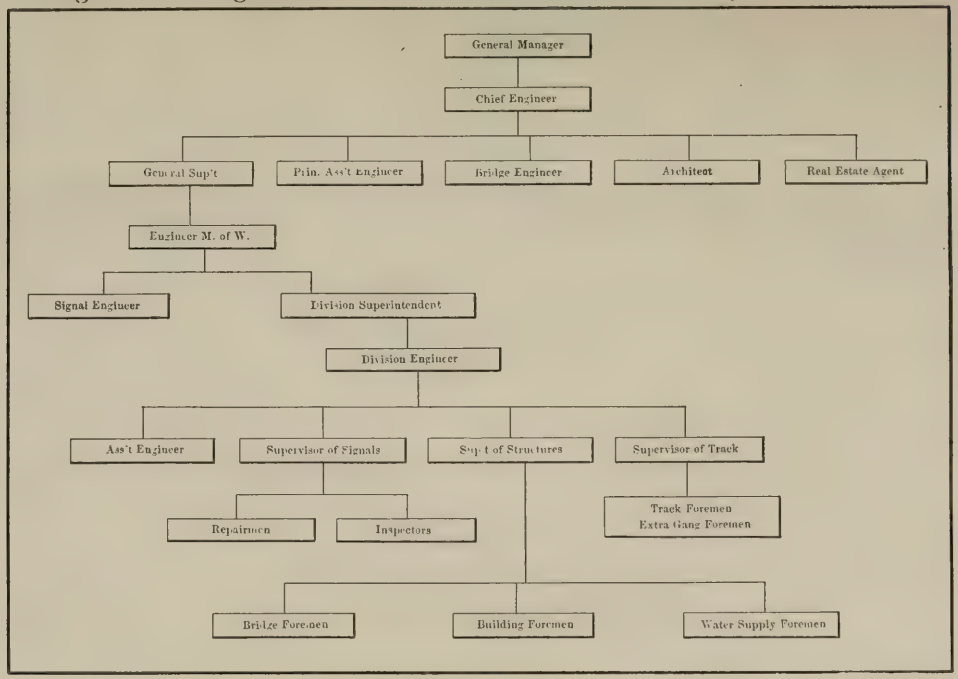
D. D. Carothers, Baltimore & Ohio Southwestern Railroad, Cincinnati, *Chairman;*
W. J. Wilgus, New York Central & Hudson River Railroad, New York, *Vice-Chairman;*
E. H. Fitzhugh, Central Vermont Railway, St. Albans, Vt.;
G. A. Quinlan, Houston & Texas Central Railway, Houston, Texas;
James Oborne, Canadian Pacific Railway, Winnipeg, Man.;
T. F. Whittelsey, Toledo & Ohio Central Railway, Toledo, O.;
C. S. Churchill, Norfolk & Western Railway, Roanoke, Va.;
J. T. Mahl, Southern Pacific Co., Houston, Texas;
F. B. Harriman, Illinois Central, Dubuque, Iowa;

Committee.

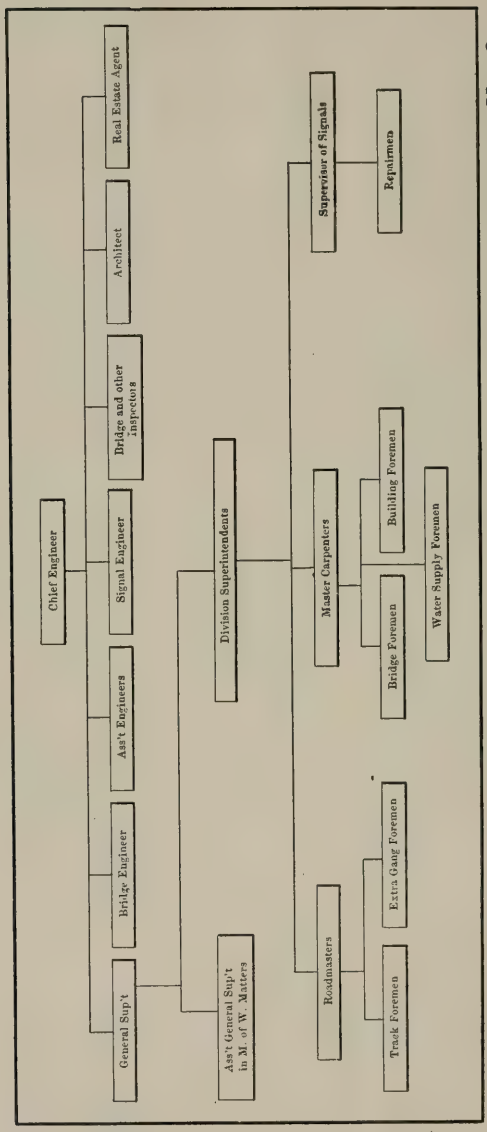

President
Chief Engineer
Prin. Ass't Engineer
Engineer of Structures
Engineer of Track
Engineer of Real Estate
Accountant
General Duties
Resident Engineers on
New Construction
Ass't Engineer Bridges
Ass't Engineer Buildings
Mechanical Engineer
General Designing
Ass't Engineer
Surveyors
Draughtsmen
Lawsuit Testimony
Clerks
Statistician
Division Engineers
Assistant Engineers
Supervisors of Bridges & Buildings
Supervisors of Track
Bridge Foremen
Building Foremen
Water Supply Foremen
Iron Bridgemen, Carpenters,
Masons, Pile Drivers etc.
Carpenters, Painters,
Roofers, Masons etc.
Plumbers, Mechanics, Pumpers
Section Foremen
Extra Gang Foremen
Wreckers
Snow Equipment
Section Men
Steam shovels, Laborers etc.

No. 1.

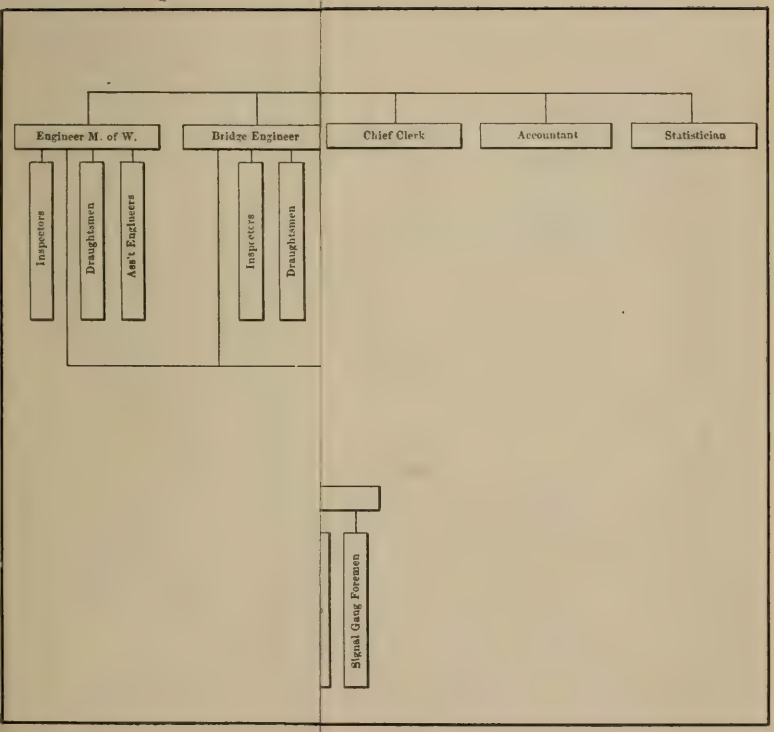
Diagram of Organization of a Maintenance-of-Way Department.



No. 2.


Chief Engineer
General Supt
Bridge Engineer
Asst Engineers
Signal Engineer
Bridge and other inspectors
Architect
Real Estate Agent
Asst General Supt in M. of W. Matters
Division Superintendents
Roadmasters
Track Foremen
Extra Gang Foremen
Master Carpenters
Bridge Foremen
Building Foremen
Water Supply Foremen
Supervisor of Signals
Repairmen

No. 3.


Engineer M. of W.
Bridge Engineer
Chief Clerk
Accountant
Statistician
Inspectors
Draughtsmen
Asst Engineers
Inspectors
Draughtsmen
Signal Gang Foremen

Chief Engineer
Engineer of Tests
Architect
Draughtsmen
Inspectors
Assistant Engineers
Division Superintendent
Division Engineer
Assistant Division Engineer
Supervisor of Tracks
Supervisor of Structures
Supervisor of Signals
Telegraph

Mr. D. D. Carothers (Baltimore & Ohio Southwestern) :— Last year I gained a good deal of notoriety and in being introduced to gentlemen they would say: "You are the man your Committee wouldn't agree with." We find a great deal of difficulty in trying to harmonize the different organizations that exist in the United States. There are conditions over which the engineers have no control, that go far toward making the organization of the maintenance-of-way department. One of the things necessary before anything can be done toward establishing an organization would be to obtain a definition as to what a maintenance-of-way department is, or of what it consists. In our correspondence we have secured a few definitions, and the Committee will be very glad to have some discussion on this part of the report. The main differences in the organizations that exist in this country are as to whether the Division Superintendent should be in full charge of the operation of his division, or whether it should be done by a Division Engineer or some officer reporting to the head of the department. The report gives the information we have collected upon this particular feature. There is also at this time an apparent disposition to eliminate the General Superintendent from maintenance-of-way matters, as would seem to be the case from the information received from the different railroads in our correspondence with them, leaving him entirely to transportation and machinery matters. We have a few typical organizations as they exist in this country. We received a great number, but these seem to be the most typical, with the exception of the last one, which is from a member of the society who offers it as a typical organization which is more elaborate than the others. The Committee would be glad to have some discussion upon this head, to see if they can possibly formulate an organization that would apply to the entire country. Before anything can be systematically done toward establishing rules we should know the character of the organization for which we propose the rules, and therefore we have not considered the question of rules in this report.

Mr. C. E. Lindsay (Southern Railway) :—On the second and third diagrams it would appear that in those organizations the General Superintendent reported to the Chief Engineer. Is that the intention?

Mr. Carothers:—That applies to all questions of maintenance-of-way. If you do not like that you can turn over the page and you will find organization No. 4, relating to another branch of the service, where the General Superintendent is eliminated.

The President:—The object of all organizations is to obtain results, and in a railway organization the ultimate object is the transportation of freight and passengers—the handling of the traffic of the road in a safe, expeditious, and economical manner, in order that the greatest net returns may be realized. It is not merely a matter of fine tracks or fine structures, nor a question of powerful engines and beautiful cars. All these elements are of importance only as they relate to and aid in increasing the net revenues. This point we should bear in mind in everything concerning organization. Another point is that, while theoretically, popular government may be conducted on the lines of democracy or republicanism—business can only be conducted on the lines of absolute despotism. That despotism must be intelligent in order to obtain the best results, but the man who is held responsible for these results must be invested with authority—he must have power in order that he may obtain the results desired. In the initial organization on our older roads, years ago, that man was, of course, the Superintendent. At that time, General Managers, Assistant General Managers, General and Assistant General Superintendents, Vice-Presidents —First, Second and Third—Chairmen of Boards, etc., were unknown. The President, generally, was the promoter or financial man, but the Superintendent was the autocrat who ran the railroad. All these other organizations came later, and today, to obtain the most efficient organization, it is necessary that the greatest amount of power possible should be placed in the hands of the Division Superintendent, who should be directly responsible for everything concerning the operation of the road—transportation and maintenance on his division. He should be a capable man—a man broad enough to hold a position of that kind. In his organization he should be assisted by a master mechanic, who looks after and provides for the machinery; he should be assisted by a roadmaster, or an engineer of maintenance-of-way, or whatever you choose to call him, who should

provide the track, and in his transportation department he should be provided with a trainmaster and a dispatcher, who operate his trains—but the Division Superintendent himself should be the general manager of that division, and in no other way, it seems to me, can we obtain economical results. There must be unity of purpose. One man must be in absolute control. It should be so arranged that the trainmaster will not lay out the ballast trains, because he does not consider the roadmaster work important, or because the Division Superintendent winks at it, as he is not responsible, being only interested in getting trains over the road, and if he is not in control of the road department, he is only indirectly responsible for the work trains—he feels that the responsibility is divided. Now, it appears to me that upon that proposition our larger organization must be built. Of course, a little further along it is necessary to have a General Superintendent, and still further along it is necessary to have a General Manager. Where there is a General Manager, the Chief Engineer should hold the same relation to him that the roadmaster does to the Division Superintendent. The object of having a general management is, of course, to control a greater or less number of division organizations, in order that there may be unity of purpose and uniform methods used over the entire system—that the road may be operated, not for the benefit of any particular division, but for the benefit of the road as a whole. When you come to the larger organization, you will find that it is economy to pay high salaries in order to secure the right results. You therefore employ a bridge engineer; having a Chief Engineer, you engage a Signal Engineer; you employ a superintendent of water supply. These men are intended to concentrate that class of experience and knowledge in the hands of what might be called a staff—which it woud be impracticable to maintain on one division alone—but which are intended to supplement the division organization. The application of that knowledge to the division organization and the control of the division organization by the staff organization should be such that while it will accomplish the best results in uniform methods and advancing of standards, etc., and obtain the benefit of the broader knowledge of the more expensive men, it should not disturb the responsibility of the division organization.

From my point of view, it seems to me that somewhere along these lines we will eventually get the best results in our organizations, regardless of the titles you give your officers—regardless of our pride as engineers in our work or our desire to get entire control of it. The division organization should be absolutely a unit in itself. The general organization should be a staff organization, exercising general control. Of course, on some roads there exists an organization in which the president—the roads being compact or running through the same character of country and having uniform track conditions—is the actual executive officer and occupying the same position on the road as does the Division Superintendent on his division. This particularly applies where several roads are combined under one ownership, and where Presidents are practically Division Superintendents. In these cases we have Chief Engineers reporting directly to the President—of General Superintendents reporting directly to Presidents; but there we simply have a division organization repeated on a larger scale.

Mr. W. S. Kinnear (Michigan Central):—In the plan as outlined by you, I do not understand you mean to do away with the time-honored title of Chief Engineer?

The President:—Not at all. The Chief Engineer would head the general Road Department staff. His duties should be the central control over the Division Superintendents—whether he exercises that control in direct touch with the Division Superintendent or through the General Superintendent or Assistant General Superintendent, or whatever officer he reports to concerning expenditures on his division. But when it comes to the expenditure of the money—after the force is fixed, the rail and the tie allowances determined, the amounts for bridge repairs, water supply, station repairs, etc., allotted—after these allowances are outlined for the year, the Division Superintendent should have the absolute control as to the actual expenditure of the money and the control of the details.

Mr. Kinnear:—In other words, if the General Superintendent was eliminated entirely from maintenance-of-way matters, the Division Superintendents would report to the Chief Engineer in all matters pertaining to maintenance-of-way. Is that right?

The President:—I think that as a rule an organization of that kind would give the best results.

Mr. W. K. McFarlin (Delaware, Lackawanna & Western): —Mr. President, I do not agree at all with your suggestion that the Division Superintendent should have charge of the engineering. I see no more reason why he should do it than why he should collect the freight that he hauls or build the cars. It seems to me that a Division Superintendent—if the division is not long enough it should be made so—has got all he can do to look after his train service. Give him his good track and he can make his time-cards for it. I think he has all he can do, and the maintenance-of-way and the construction can be done by the engineering department, without the assistance of the Division Superintendent. I believe this, though possibly because I have been accustomed to it.

Mr. Kinnear:—I would like very much to hear an expression of opinion from some of the General and Division Superintendents who may be present on this subject.

The President:—We have struck one thing that we do not agree on, and that ought to lead to a full and free discussion on it. Colonel Prout, what are your ideas?

Mr. H. G. Prout (Chief Editor Railroad Gazette):—You have expressed them so completely and admirably there is nothing left for me to say. It seems to me that you have been describing very accurately the organization of the Pennsylvania Lines. You find there the Division Superintendent in charge of the engineering work on his division. And it seems to me that the vital principle in the whole thing is the concentration of responsibility. When a subordinate officer has to report to two different superior officers, sooner or later you will get into trouble. There will be a conflict of jurisdiction. And that is the theory of modern military organization. As military operations have extended over greater areas and greater masses of troops are involved in those operations, they find that it is more and more necessary to devolve complete responsibility upon the commanders of the smaller units. Give them a job to do and then hold them responsible for doing it. So that so far as that goes it does not seem to me that the suggestion of the President could be improved upon.

There is another point in this matter, and that is if there is any reason why the Division Superintendent, as matters stand

today, should not take care of the engineering part of the work of his division, that can be easily arranged for. Make the Division Superintendents engineers, which is probably what is coming.

Mr. W. E. Dauchy (Chicago, Rock Island & Pacific):—This question of division of responsibility in the plan that you have outlined is merely removed from the men under the Division Superintendent to some other point along the line. Now, if the Division Superintendent is wholly responsible for everything under him, in all departments, maintenance and operation, he must of necessity report to someone above him. Now, is he to receive his instructions from the General Superintendent, also from the Chief Engineer, also from the Superintendent of Motive Power? Is not that condition of division of responsibility coming in there instead of a point further down the line?

The President:—If the discord and the division of responsibility is removed from the division, there will be no trouble. As a matter of fact, where a man of the gauge and breadth of a Division Superintendent reports to three or four different officers on different matters that have no relation to each other, there is little opportunity for confusion of authority.

Mr. A. W. Sullivan (Illinois Central):—I quite agree in principle with what has been stated as to the necessity of there being in the organization of a railway a point at which all authority focuses or centralizes, and from which emanates the force that directly controls the work being done, and from an experience of many years with different forms of organization it is my judgment that making the Division Superintendent the center of authority for all the work within his jurisdiction gives the best results. The expansion of railway organization, the increasing burdens which come with the increased density of the business on all lines, make it more necessary now than ever before to have what might be termed a general staff upon the railroad. That is a part of the organization to which is given the devising of methods, the determining of ways and means by which the results of operation shall be developed, and also of fixing standards for maintenance, as well as standards of efficiency for operation; so that all the department officers and the

Superintendents of divisions will know by what measure, by what scale of efficiency, their service is being judged; so that they can know exactly along what lines they are expected to perform their duties, and what constitutes efficiency in their different departments. By vesting the Superintendent of a division with authority in all of the three departments—maintenance-of-way, machinery and transportation—it places in his hands an opportunity for so uniting and so arranging the inter-relations of the work of those departments that there can be no question as to who is responsible for results in the event of their not being satisfactory. It is the necessity for having some fixed point of accountability which will force the railroads to adopt some such plan, either the particular plan of making the Division Superintendent the central authority for active operation, or some plan equivalent to it; but in that same connection there must be for the guidance of the Superintendent a general staff, which will indicate along the most intelligent lines the practice that he should follow in the performance of his duty.

Mr. W. L. Breckinridge (Chicago, Burlington & Quincy):—May I ask what organization is in effect on the Illinois Central?

The President:—The Division Superintendents have charge of everything on their division, reporting to the Chief Engineer on all matters relating to maintenance, as far as the lines north of the Ohio River are concerned. South of the Ohio River the road is under the control of an Assistant General Superintendent, who reports to the Chief Engineer on all matters relating to maintenance-of-way, and to the Assistant General Manager on all matters relating to transportation. North of the Ohio River, the Division Superintendents report to the Chief Engineer on all matters relating to maintenance-of-way matters, to the Superintendent of Machinery on machinery matters, and to the Assistant General Manager on transportation matters. The Superintendent of Machinery and the Chief Engineer in turn report to the Assistant General Manager on matters relating to their departments.

Mr. F. E. Bissell (Lake Shore & Michigan Southern, by letter):—The actual conditions that obtain, and not theoretical ones, are those which have always to be met. All remarks fa-

voring the Division Superintendent as the unit of operation, in whom all power should be centralized, are based on the supposition that the person occupying that office is broad-gauged, liberal-minded and well-informed in all matters pertaining to transportation, motive power and maintenance-of-way.

But do all holding such office have all these very necessary requisites? And if not, what then, is the logical result of this plan of organization? Nothing but failure—a failure that too often affects most disastrously both the master mechanic and the Engineer of Maintenance-of-Way, though each may be very capable men in their respective departments. The success of the three departments would depend on the efforts of one man and that man only a minor official in the complete organization of a railroad.

Some lines seem to have an organization in which the unit of operation is the Division Superintendent. The writer uses the word "seem," as a careful investigation will often show that the Division Superintendent is not in many such cases the unit in all things pertaining to the operation of his divison.

In all problems presenting themselves for solution there are three items to be considered: What to do, how to do it and when to do it, and on at least one large system where the Division Superintendent seems to be the unit of operation, he can only say—when to do it. A locomotive may be ordered out of service, but the motive power department say what repairs shall be made, and how they shall be made, while the Division Superintendent can only say when or in what month the expense of the work shall be incurred.

The Committee has given the total mileage of the two types of organization, and if it had been given five years ago there would have been a greater difference, but that does not show which is the better. A comparison of results would have been more to the point.

A very successful railroad President has said: "In these days nearly all railroad men must be specialists. The time has passed when immediate supervision of all departments can be vested in one man except in the case of roads of very small mileage. The great mass of railroad workers must specialize in order to obtain employment or advancement. He may hope for promotion in his specialty, but not generally outside of it."

The Chief Engineer is a specialist in maintenance-of-way and construction. Why, then, is it not better in every way to put him in charge of all such matters?

A railroad is like a man in that it must have a good constitution to meet the struggle which only ends in the "survival of the fittest." It is the engineer who gives the road its constitution when he determines its location, its grades, its curves and its roadbed. If an engineer does this for a road, why is he not the best one to remain in charge of its physical properties?

Good track is one of the essentials of success of a railroad. Engines and cars can be leased, business can be got by low rates and the promise of quick dispatch; but first-class track, convenient and commodious stations, excellent water supply and good bridges can only be obtained by years of careful, painstaking and laborious work under the direction of one who is thoroughly versed in maintenance-of-way.

Our President has been understood to say that too much reliance should not be placed on personal experience. But does not the aggregate of personal experience make practice? And practice either proves or disproves the theory. "The proof of the pudding is in the eating."

One Superintendent of over one thousand miles of road criticised a location and estimate of cost of a line because it would cost more per mile than the line with which he had previously been connected, not knowing the difference between a line built on the plains of Kansas up the valley of a large river and one to be built north and south across the natural drainage of the foothills of the Rocky Mountains.

One who had been an operator, train dispatcher and trainmaster suddenly became Superintendent of over four hundred miles of road. His great object in life was to reduce expenses. The engineer was dispensed with. One roadmaster with no assistant was put in charge of track; requisitions were cut down; ties would have to last over sixteen years, according to the number of new ones allowed each year. After five years, the annual report says, $1,350,000 is needed at once to put the line in shape to do business. Another Superintendent had the maintenance-of-way added to his duties. Transportation matters were neglected to give time to look after that of which he knew but

little, resulting in failure and carrying down the Engineer of Maintenance-of-Way with it. A good transportation man spoiled in attempting to make a maintenance-of-way man out of him.

If there is any part of a railroad which requires more than another a specialist it is that part which is in control of construction and maintenance-of-way. The best work is done by subordinates when they feel their efforts are appreciated and the difficulties under which they labor are understood. Who can appreciate and understand in all matters pertaining to the maintenance-of-way better than the Chief Engineer?

Uniformity in both design and method is very desirable. What better way is there of attaining that result in all things pertaining to the maintenance-of-way than by having the Chief Engineer directly in charge?

Is it not the better plan to have each department in charge of a specialist in that particular line? The Traffic Manager in charge of getting the business; the Superintendent in charge of transportation; the Chief Engineer in charge of maintenance-of-way and construction and the Superintendent of Motive Power in charge of the locomotives, cars and machinery—all standing on an equal footing before the General Manager.

Mr. E. B. Cushing (Houston, East & West Texas, by letter):—The question of the most effectual and truly economic organization of a railroad is an interesting one, but there may be some doubt as to the propriety of this Association considering or attempting to pass judgment on this matter beyond the interior organization of the maintenance department. The scope of authority allotted to this department and the process through which its reports should reach the President may be considered more properly by the General Managers' associations. This matter has been considered by the Committee, however, and it may therefore be discussed. It has been my lot to serve companies that have plans of organizations varying from the one suggested by the Committee to one in which the General Roadmaster was the head of maintenance, and the civil engineer looked on as a necessary evil to be consulted as little as possible. In my humble opinion the best organization is that in which the Division Superintendent is the general manager of his division. The track, bridges, water service, stations, trains and motive power are

the means through which the traffic is handled. The management of these forces should center in one officer who is on the ground, and in close personal contact with the men who do the work. If that officer is a competent civil engineer, who has reached his position through the various positions of section foreman, assistant engineer and roadmaster, and has taken time to acquire telegraphy—the language of railroading—and has absorbed a knowledge of various other details of the operation of railroads, the arrangement might be said to be perfect. If this work is more than a man can do, the matter should be met by shortening divisions rather than of making more departments. On small roads the Superintendent should report to the General Manager, but where there are several divisions the general staff will embrace a Chief Engineer, who will prescribe standards and matters of policy in maintenance. Notwithstanding some well-managed roads are organized on different lines, the idea that better results are obtained by the direct methods possible only by concentrated authority seems to be founded on reason and good practice.

The President:—The next in order is the report of the Committee on Track.

REPORT OF COMMITTEE No. 5.—TRACK.

To the President and Members of the American Railway Engineering and Maintenance-of-Way Association:

Your Committee has necessarily been unable to cover all of the subjects assigned to it, and the reports that are submitted are preliminary only, and as there has been no meeting of the Committee the report is composed of individual expressions of its members, as much more time than the Committee has been able to devote to these subjects is needed to prepare a comprehensive report on all of them. The work of the Committee has been delayed by reason of the resignation of the Chairman, and the recent resignation of four other members.

MAINTENANCE OF LINE.

By H. C. Landon.

With the increased speed of locomotives and trains comes the demand for a nearer perfection of line on tangents and curves. The permanency depends, first, upon the soil where the track is laid, and then upon the character and amount of ballast. The foundation of all track being the earth as we find it, no matter what ballast is placed thereon,

it is impossible to construct a road and perfectly maintain the line excepting at points where it passes over permanent structures that are set upon foundations where no settlement is possible. The approach toward perfection in line and the maintenance of the same depends entirely upon the character of the ballast and the amount of traffic which goes over it.

A road having light traffic and light locomotives and comparatively slow passenger trains is not called upon to try for that perfection of line that is necessary for a road having heavy traffic and using heavy equipment. At all times such line and surface should be maintained that it is perfectly safe for the traffic that is moving over it.

Where the passenger business is light and passenger trains are comparatively slow and where most of the business is freight, if the track is slightly out of line it does not affect the comfort of passengers, nor is there any particular danger of damage to freight traffic. If it was endeavored to keep such track in perfect alignment, the expense would be a waste rather than an economy. There should be, however, a tendency, no matter what the traffic may be, toward getting the line in the best possible shape under the conditions. The track, as originally staked out, does not at all points remain as laid, nor is track laid always with the proper care. Center stakes are not followed, and frequently in tracing the old line it is found that track has moved from between 1 to 2 feet or more, either from the settling of the tracks, or by the trackmen's lining bars. This deviation from the original line on curves often produces sharp places which cause a disagreeable throw.

Of 19 roads replying to the circular sent out by the Committee, 10 set center stakes with the transit, placing them from 100 to 200 feet apart, so as to move the track as little as possible, on tangents. The track is thrown to center stakes by trackmen in the most convenient season, and this is ordinarily when the road is being re-tied, or ballasted. Tangents are thrown then to exactly straight line. There is a good deal of labor saved in this method of lining, as the track is thrown to where it belongs and the work of lining is practically completed as the section gang goes over it.

One side of the track, east or west, north or south, or rail on the mile-post side is usually taken for the line side of the track by the foreman in re-aligning the track. Where the tangents are short and the curves re-aligned, the tangents are frequently lined by the eye between the points of curves. Track lining should, if possible, be done before surfacing.

Curves should be adjusted in the same manner as tangents; center stakes should be set. Sixteen roads out of the 19 make it a practice to put curves in proper line by setting stakes with the transit. While none of them so state, it is presumed that the work of throwing or adjusting track after the stakes are set is done when the track is being worked over. Very poor alignment can be greatly improved by the introduction of easement, or spiral, curves, and by their judicious use these improvements can usually be made without varying from the old alignment sufficiently to have the track itself on a new roadbed.

Fourteen roads out of the 19 use some form of easement curve. One road states that having found no particular advantage in the easement curve, its use has been abandoned. It would seem, however, from the large number of roads using easement curves, that some form of easement curve is necessary to obtain the best results.

Three roads use some form of the "Searles" spiral, 2 roads use some form of the "Holbrook" spiral, and 1 road uses the cubic parabola. Any form of curve which gradually changes the degree of curvature will probably answer, but that form of spiral which changes the curve and makes a long and easy approach to a curve will give the best results. One railroad uses the form of the "Holbrook" spiral, which changes 1 degree in every 100 feet of its length, as its standard. Sharper easements are used when it is necessary. This makes a very easy approach to a curve, as the elevation changes very gradually. The Erie Railroad did use for its standard a spiral changing 1 degree in every 60 feet. This spiral makes a light and easy change from tangent to curve. The change in curvature and elevation is light and easy. With this spiral, at a speed of 40 miles per hour, a train will pass over 1 degree of curvature, and, say, 1 inch of change in elevation per second. Even at the rate of 60 miles per hour it would pass through the same distance in about two-thirds of a second. At the rate of 60 miles per hour, this easement curve would produce no ill-effects, although for a rate of 60 miles per hour a lighter easement than 60 feet per degree is desirable, and should be used where practicable. Where conditions have made it necessary, spirals changing 1 degree every 15 feet have been used to advantage with speed of 45 miles per hour.

Generally the easement curves are used and applied to all curves of 2 degrees or more and between parts of the compound curve where curvature differs more than 2 degrees. Stakes in the easement curve should not be set farther apart than 25 or 30 feet.

The labor of locating an easement curve is but little more than that of the circular arc. It is advisable, on high-speed lines, to use easements with curves of 1 degree and over. On the "Vandalia" line, curves of 30 minutes or more are eased with the "Holbrook" spiral.

Transition curves enable the elevation to rise uniformly as the curvature increases. If the circular arc is at the proper elevation, then the train movement passes from the tangent to the circular arc uniformly with the increase in elevation.

The perfect line is probably unknown. It is the endeavor, in order to realize the best service, to attain as nearly perfect alignment as possible. Maintenance of line depends upon foundation.

Tangents and curves should be laid to exact line and curvature, allowance being made for expansion, and the track accurately gauged. Careful gauging of track materially helps in the maintaining of line. The surface must also be maintained. The track level should always be used in surfacing track. This is not always insisted upon, or not always done.

Vertical Curves.—Vertical curves in some form are used on all roads connecting the different gradients. The Vandalia Railroad uses the following:

The vertical curve shall consist of as many chords as there are whole tenths of a foot in the algebraic difference between the two gradient lines, less one. The length of chord shall generally be 100 feet. The change from one gradient line to another shall be made by a variation in rate of grade for each chord equal to the algebraic difference between the rates of the two gradient lines, divided by the whole number of tenths in the algebraic difference; this change of rate is approximately 0.1 feet per chord.

To change from the grade of plus 0.6 per 100 to a grade of minus 0.5 per 100. Number of chords in a curve are 11 minus 1, equal 10. Length of curve 10x100, equal to 1,000 feet. Rate of change from chord to chord equals $\frac{1.1}{11}$ equals 0.1.

Rate	of	grade	on	first	chord	equals	plus	0.5
"		"		second	"	"	"	0.4
"		"		third	"	"	"	0.3
"		"		fourth	"	"	"	0.2
"		"		fifth	"	"	"	0.1
"		"		sixth	"	"	"	0.0
"		"		seventh	"	"	minus	0.1
"		"		eighth	"	"	"	0.2
"		"		ninth	"	"	"	0.3
"		"		tenth	"	"	"	0.4

If it is necessary for any reason to change the length of the curve the change is made in the length of chord, the rate of change remaining the same.

Ordinarily the changes of vertical curves are made from 500 to 1,000 feet, depending upon the local conditions, but some approximate uniform curvature or change should be assumed in making the change from one gradient to another.

The proper method of tamping depends upon the character of ballast used. If gravel, cinders or natural soil are used for ballast, the track shovel seems to give the best satisfaction as a tool for tamping. For rock ballast the tamping pick is generally used. Some roads use track shovel provided with iron handle and this iron handle is used for tamping the cinders or earth compactly under the tie. Other roads use a tamping bar, a separate tool altogether, for tamping ballasted track.

The Chattanooga, Rome & Southern rules in the Maintenance-of-Way Department in reference to tamping are as follows:

In surfacing track, raise the ties as little as possible off the old bed. To get level track on tangents and the proper elevation on curves, except where there are small dips in grade not exceeding 6 inches, these must be taken out; any exceeding 6 inches will be taken out by special instructions. In raising track the dirt must be thoroughly tamped under each tie from a point 18 inches inside of rail to end of tie. Special attention must be given that the tie is tamped directly under the rail, which, because it is a difficult point to reach, is apt to be neglected by the

men. Tamp all ties as evenly as possible, and always tamp the joint ties last. The level must be used constantly, not only at each joint and center. In using track jacks they must always be set on outside of rail. Good track means track that is level on tangents and properly and evenly elevated on curves.

The dirt must always be packed hard around the ties in filling in, and to do this pack with feet, layer by layer, so that the water will turn off quickly instead of seeping through bed of tie, causing the track to churn. After track is surfaced dress off as follows:

Dress dirt level with top of tie to 18 inches on each side of center, then slope to 1½ inches under rail and then to bottom of tie ½ inch from each end, then to bottom of standard ditch.

The general rules of the Chicago, Milwaukee & St. Paul are as follows:

Track should be surfaced at least once a year, so as to give it a uniform bearing. When surfacing, a track level must be used. When track is laid "Square Joints" all joint ties must be tamped solid for a distance of 16 inches on inside of rail to end of ties. Center of ties must be tamped loosely, so as to prevent track from becoming center bound. Before the close of each day's work, track should be brought to exact line, and properly dressed up. In no case must track be left over night without being properly filled in and dressed up. When track jacks are used, they must invariably set on the outside of rail. On straight lines, except where they approach curves, the tops of rails must be level with each other.

From the replies received from the different roads, in reference to tamping, it seems to be the general opinion that the tamping should be thoroughly done, from the end of the tie to from 12 to 14 inches from the inside of rail, and in the center of the track very little or light tamping should be done.

THE HOLBROOK SPIRAL.

Of 23 roads replying to Circular No. 16, on Track, 14 roads use some form of spiral curve. Two roads report using the Holbrook Spiral, 3 roads the Searles Spiral, and 1 road the Wellington Transition Curve. It is possible that a greater number use some form of spiral, but do not so state. It is evident that the use of some form of easement curve is recognized as necessary to secure the best track; and in connection with subdivision A, of maintenance of line, the committee thinks a short discussion of the Holbrook Spiral, as first used by Mr. E. Holbrook, and which seems to fill all the conditions of an easement curve, will be of some interest.

The Holbrook Spiral changes uniformly in curvature with the length of arc. There is an exact agreement in the curvature with the curves at connecting points. It can be located and recorded the same as a circular arc. It can be defined by the equation $D = nL$ (1) in which D is the degree of curve in minutes and L is the length of curve in feet; n is a constant which determines the rate of increase in curvature.

The other nomenclature used is as follows:

R equals the radius of the main curve.

i equals the central angle of the spiral arc.

Δ equals the central angle of the whole curve.

d equals the deflection angle from point of curve to any point of the spiral,

i — d equals the back deflection from the tangent at the point of curve to the point of spiral.

y equals the abscissa of any point on the spiral referred to the P. S. point of spiral as the origin and initial tangents as the axis of Y.

For the point H, $y = AE$.

x equals the ordinate of the same point measured at right angles to the above axis.

For the point H, $x = EH$.

y_0 is the abscissa of the PC of the main curve produced backwards, ie., of the simple curve without spiral.

For the point C, $y_0 = AC$ and x_0 equals the offset between the initial tangent and the parallel tangent of the main curve produced backwards of the ordinate of the PC of the produced main curve.

For the point F, $x_0 = C^1 F$.

T equals the tangent distance for spiral and the main curve and equals the distance from A to B intersection of the tangents.

E equals the external distance of the spiral and the main curve.

The Fig. 1 shows the spiral applied to both ends of the simple curve, AH being the length of the spiral at one end,
HJ being the main curve and JM length of spiral at the other end of main curve.

The central angle of the arc whose length is $\frac{l}{100}$, whose rate of curvature varies uniformly from O to D is $\frac{1}{2}$ D $\frac{l}{100}$, or substituting

The value of D from the equation $D = nL$. equation (1).

i equals $\frac{l^2}{200n}$ (2) Reducing this from the angle to the arc by multiplying the length of one minute.

$i = \frac{nl^2}{10800 \times 200n}$ representing the constant factor by a this reduced to $i = al^2$.

The differential equation for x and y in terms of i and l are

$$dx = \sin i.\ dl = \sin al^2.\ dl \quad (1)$$
$$dy = \cos i.\ dl = \cos al^2.\ dl \quad (2)$$

Expanding $\sin al^2$ and $\cos al^2$ by Maclaurin's theorem, and integrating the resulting equations, there follows:

$$x = \frac{al^3}{3} - \frac{a^3l^7}{42} + \frac{a^5l^{11}}{1320} - \frac{a^7l^{15}}{75600} \quad (3)$$
$$y = l - \frac{a^2l^5}{10} + \frac{a^4l^9}{216} - \frac{a^6l^{13}}{9360} \quad (4)$$

The deflection angle is $d = \tan^{-1} \frac{x}{y}$ (5).

A close approximation to d is obtained as follows:

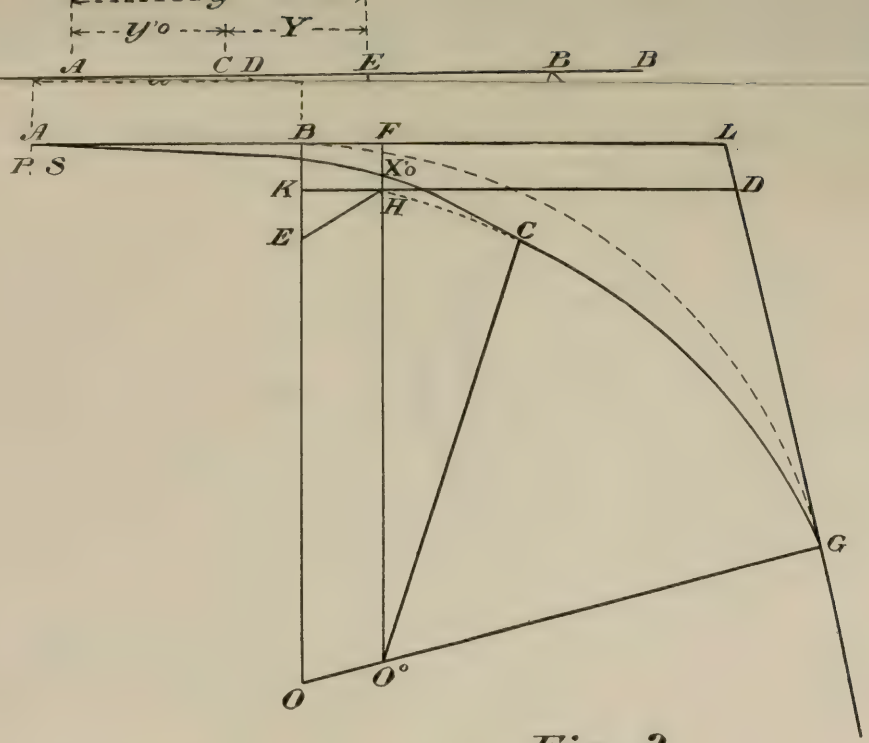


Fig. 3.

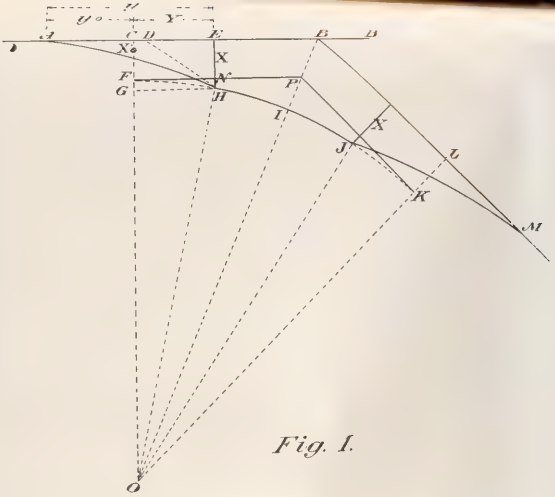


Fig. 1.

Line D-H is tangent to curve and spiral.

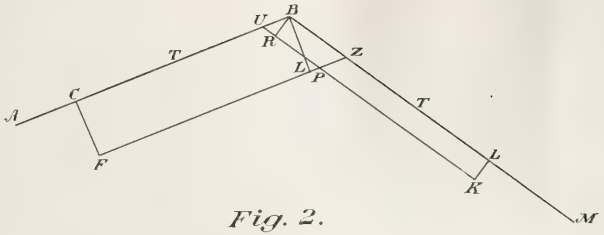


Fig. 2.

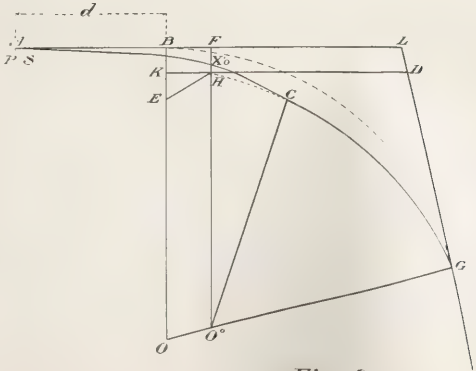


Fig. 3.

Since d is small, the arc may be substituted for the tangent giving $d = \frac{x}{y}$ and as the series for x and y decrease rapidly, the first term of each will give the ratio with all the precision practically required, therefore:

$\frac{x}{y} = \frac{1}{3} al^2$ or $d = \frac{1}{3} i$ (6)

The ordinate $x_0 = FC = HE - HN$, but $HE = X$ and $HN = R$ vers i, hence:

$x_0 = x - R$ vers i. (7).

A close approximation to x_0 is obtained as follows:

$R = \frac{50}{\text{sm} \frac{1}{2} D}$ or approximately $R = \frac{50}{\frac{1}{2} D} = \frac{100}{D}$, but

$i = \frac{1}{2} \frac{DL}{100} = al^2$, or $D = 200\ al$, hence: $R = \frac{1}{2} al$. Also,

vers $i = 1 - \cos i = 1 - \cos al^2 = 1 - (1 - \frac{a^2 l^4}{2} + \text{etc.})$, or approximately,

vers $i = \frac{a^2 l^4}{2}$, therefore, R vers $i = \frac{1}{4} al^3$, but since

x is very nearly $\frac{1}{3} al^3$, R vers $i = \frac{3}{4} x$, hence,

$x_0 = \frac{1}{4} x$. (8).

The ordinate $Y_0 = AC = AE - GH$, but $AE = y$ and $GH = R \sin i$, hence

$y_0 = y - R \sin i$. (9).

The above formulas are the formulas necessary for the compilation of the table necessary for use in calculating the table for the applying of easement curves. I give below the necessary formula for use in applying the spiral to simple curves with same spiral at each end.

From the diagram it is very easily known how these formulas are determined, and it is not necessary to go into detail of deriving them here.

In combining the spiral with the circular arc it should be remembered that the circular arc is computed to join the auxiliary tangents distant x_0 from the actual tangents and that the point of spiral P.S. is y_0 beyond where the circular arc joins the auxiliary tangents.

$$T = (R + X_0) \cdot \text{Tan } \tfrac{1}{2} \Delta + Y_0 \quad (10)$$

$$E = \frac{R + Y_0}{\cos \frac{1}{2} \Delta} - R \quad (11)$$

$$R = \frac{T - Y^0}{\text{Tan } \frac{1}{2} \Delta} - X_0 \quad (12)$$

$$R = \frac{E \cos \frac{1}{2} \Delta - X_0}{1 - \cos \frac{1}{2} \Delta} \quad (13)$$

When it is necessary to use a shorter spiral at one end than at the other, the spiral arcs AH and JM are unequal. The auxiliary tangents FP and PK, figures 1 and 2, are unequally distant from the actual tangents. Denoting AC by y_0, CF by x_0, LM by y'_0 and KL by x'_0 we have the following formulas, which are easily derived:

$T = AB = AC + FP + PZ - LZ = Y_0 + R\tan \tfrac{1}{2}\ \Delta + \frac{X_0^1}{\sin} - X_0 \cos \Delta$

$T^1 = BM = LM + PK + PU - UR$

$T^1 = Y_0^1 + R\tan \tfrac{1}{2}\ \Delta + \frac{X_0}{SIN\ \Delta} - X_0^1 \cos \Delta$

The angle FOH = i and the angle JOK = i^1

$HOJ = \Delta - (i + i^1)$

Where the curves are long and it is unadvisable to attempt to secure a uniform curve, a good line can be secured by light compound curves, then the arc joining the tangents may be eased off by the following method:

A point should be selected in the line as at G, Fig. 3, some 500 or 600 feet from the end of the curve, or closer, if necessary, the tangent G to the curve at that point is determined and the angle of intersection at L is measured as well as the distance LG. Let R′ be the radius of the simple arc GB connecting GL and AL.

With the spiral CA and the circular arc GC when produced must join the auxiliary tangent HD distance, x_0 from AL. Let R be the radius of an arc to join HD, then $R = R^1 - \frac{X_0}{\text{vers } \Delta}$ reducing as $X_0 = X - R$ vers i, vers $\Delta = 1 - \cos \Delta$, and vers $i = 1 - \cos i$. Making the substitution,

$$R = \frac{R^1 \text{ vers } \Delta - X}{\cos i - \cos \Delta} \quad (16)$$

denoting AB by d we have

$$d = y_0 - (R - R^1) \sin \quad (17)$$

Since AL = BL + d the point of spiral is thus located at A.

After locating the spiral AC the arc CG is continued, compounding when necessary. At the other end of the curve the same method is pursued in making the easement.

In introducing the easement curve between the parts of a compound curve, the most satisfactory way is to use the easement curve the same as compounding, and fit it in by trial rather than to attempt to locate it by calculation. The formulas that are given are practically all that are required for ordinary practice. For general practice n should preferably be equal to one, giving the 60-foot spiral, if n equals 5-10, we have the 30-foot spiral. The tables given in connection with this, giving the value of D, L, X, Y'_0 and D for intervals of 10 feet for the 30 and 60 foot spiral up to 8 degrees, the other for intermediate values can be interpolated. A table is also given for the 18-foot spiral for intervals of 6 feet, n in this case = .3.

It is convenient to have tables tabulated for intervals of 1 foot in length. The functions for the 20 or 40 foot spirals can be taken from the 60-foot spiral by proportion.

On our low grade lines we are endeavoring to make curves uniform, not to exceed 8 degrees. Some of our curves are very irregular, running from 6 to 12 degrees, and it is possible without very much throw in the track, where banks will permit, to make these uniformly 8 degrees. On the mountain line the curvature is very much heavier, running from 18 to

TABLE No. 1. 60-FOOT SPIRAL.

N=1. $X_0=\frac{1}{4}X$. $d=\frac{1}{3}$ i.

D.		L.	X.	Y.	Y_0.	d.		i.	
0	10	10	.00	10.	5.00	0	0.2	0	0.6
	20	20	.00	20.	10.00	0	0.7	0	2.1
	30	30	.01	30.	15.00	0	1.5	0	4.5
	40	40	.03	40.	20.00	0	2.7	0	8.1
	50	50	.06	50.	25.00	0	4.2	0	12.6
1	00	60	.10	60.	30.00	0	6.0	0	18.0
	10	70	.17	70.	35.00	0	8.2	0	24.6
	20	80	.25	80.	40.00	0	10.7	0	32.1
	30	90	.35	90.	45.00	0	13.5	0	40.5
	40	100	.48	100.	50.00	0	16.7	0	50.1
	50	110	.66	110.	55.00	0	20.2	1	0.6
2	00	120	.84	120.	60.00	0	24.0	1	12.0
	10	130	1.06	129.99	65.00	0	28.2	1	24.5
	20	140	1.33	139.99	70.00	0	32.7	1	38.0
	30	150	1.64	149.98	75.00	0	37.5	1	52.5
	40	160	1.99	159.98	80.00	0	42.7	2°	8.0
	50	170	2.38	169.97	85.00	0	48.2	2	24.5
3	00	180	2.83	179.96	90.00	0	54.0	2	42.0
	10	190	3.32	189.95	95.00	1	0.1	3°	00.5
	20	200	3.88	199.93	100.00	1	6.7	3	20.1
	30	210	4.49	209.91	104.99	1	13.5	3	40.5
	40	220	5.16	219.89	109.98	1	20.7	4	02.0
	50	230	5.90	229.86	114.98	1	28.2	4	24.5
4	00	240	6.70	239.83	119.97	1	36.0	4	48.0
	10	250	7.57	249.79	124.97	1	44.2	5	12.5
	20	260	8.51	259.75	129.96	1	52.7	5	38.0
	30	270	9.53	269.70	134.95	2	1.5	6	4.5
	40	280	10.63	279.64	139.95	2	10.7	6	32.0
	50	290	11.81	289.57	144.93	2	20.1	7	00.5
5	00	300	13.07	299.49	149.91	2	30.0	7	30.0
	10	310	14.42	309.40	154.91	2	40.2	8	0.5
	20	320	15.86	319.29	159.89	2	50.1	8	32.0
	30	330	17.34	329.17	164.86	3	1.5	9	4.5
	40	340	19.02	339.04	169.85	3	12.7	9	38.0
	50	350	20.74	348.89	174.82	3	24.2	10	12.5
6	00	360	22.56	358.72	179.79	3	36.0	10	48.0
	10	370	24.49	368.54	184.76	3	48.2	11	24.5
	20	380	26.52	378.33	189.72	4	0.7	12	2.1
	30	390	28.66	388.09	194.68	4	13.5	12	40.5
	40	400	30.91	397.84	199.64	4	26.7	13	2.0
	50	410	33.27	407.60	204.60	4	40.3	14	00.9
7	00	420	35.74	417.35	209.55	4	54.0	14	42.0
	10	430	38.32	427.07	214.54	5	08.5	15	25.5
	20	440	41.03	436.82	219.50	5	22.8	16	8.4
	30	450	43.84	446.54	224.45	5	37.6	16	52.8
	40	460	46.78	456.25	229.40	5	52.8	17	38.4
	50	470	49.84	465.96	234.34	6	08.2	18	24.6
8	00	480	53.01	474.65	239.28	6	24.0	19	12.0

TABLE No. 2. 30-FOOT SPIRAL.

n=½.

D.		L.	X.	Y.	Yo.	d.	i.
0	20	10	.00	10.00	5.00	0 0.3	0 1.0
	40	20	.01	20.00	10.00	1.3	4.0
1	00	30	.03	30.00	15.00	0 3.0	0 9.0
	20	40	.06	40.00	20.00	5.3	16.0
	40	50	.12	50.00	25.00	8.3	25.0
2	00	60	.21	60.00	30.00	0 12.0	0 36.0
	20	70	.33	70.00	35.98	16.3	49.0
	40	80	.50	80.00	39.98	21.3	1 4.0
3	00	90	.73	90.00	44.98	0 27.0	1 21 0
	20	100	.97	99.99	49.97	33.3	40.0
	40	110	1.29	109.99	54.97	40.3	2 1.0
4	00	120	1.68	119.98	59.97	0 48.0	2 24.0
	20	130	2.14	129.97	64.96	56.3	49.0
	40	140	2.66	139.95	69.96	1 5.3	3 16.0
5	00	150	3.27	149.93	74.95	1 15.0	3 45.0
	20	160	3.97	159.91	79.94	25.3	4 16.0
	40	170	4.77	169.88	84.94	36.3	4 49.0
6	00	180	5.65	179.84	89.93	1 48.0	5 24.0
	20	190	6.64	189.79	94.91	2 0.3	6 1.0
	40	200	7.75	199.73	99.89	2 13.3	6 40.0
7	00	210	8.96	209.65	104.86	2 27.0	7 21.0
	20	220	10.30	219.56	108.89	2 41.3	8 4.0
	40	230	11.77	229.45	114.82	2 56.3	8 49.0
8	00	240	13.38	239.33	119.79	3 12.0	9 36.0

TABLE No. 3. 18-FOOT SPIRAL.

n=$\frac{3}{10}$

D.		L.	X.	Y.	Yo.	d.	i.
0	20	6	.00	6.00	3.00	0.2	0.6
	40	12	.00	12.00	6.00	0.8	2.4
1	00	18	.01	18.00	9.00	0 1.8	0 5.4
	20	24	.02	24.00	12.00	3.2	9.6
	40	30	.04	30.00	15.00	5.0	15.0
2	00	36	.08	36.00	18.00	0 7.2	0 21.6
	20	42	.12	42.00	21.00	9.8	29.4
	40	48	.18	48.00	24.00	12.1	36.1
3	00	54	.25	54.00	27.00	0 16.2	0 48.6
	20	60	.35	60.00	30.00	20.0	1 00.0
	40	66	.46	66.00	33.00	24.2	24.6
4	00	72	.60	72.00	36.00	0 28.8	1 26.4
	20	78	.77	79.99	38.99	33.8	41.4
	40	84	.91	83.99	41.99	39.3	57.7
5	00	90	1.18	89.99	44.99	0 45.	2 15.0
	20	96	.43	95.98	47.98	51.2	35.6
	40	102	.71	101.97	50.97	57.8	53.4
6	00	108	2.04	107.97	53.97	1 4.8	3 14.4
	20	114	.39	113.95	56.96	12.2	36.6
	40	120	.79	119.94	59.95	20.0	4 00.0
7	00	126	3.23	125.93	62.94	1 28.2	4 24.6
	20	132	.72	131.91	65.93	36.8	50.4
	40	138	4.25	137.88	68.92	45.8	5 17.4
8	00	144	4.83	143.85	71.90	1 55.2	5 45.6

20 degrees. An example of the re-alignment of one of the irregular curves is here given:

The intersection point B was easily located, the angle found to be 32 degrees and 30 minutes. From the point of intersection to center of track was found to be 31½ feet. The banks were wide and it was found that an 8-degree curve with an 18-foot spiral at the other end would fit the conditions very well, and throw the track about 3 feet on a hard gravel bank. Some portions of the curvature were as high as 12 degrees.

The tangent distance $T = (R + x_0) \times \text{tangent } \frac{1}{2} \Delta = 282.21$.

AH = JM = 144 ft.

i the deflection in the angle for the whole of the spiral equals 5 degrees 45 minutes.

The point A located by measuring the distance AB, BG 282.2 feet and the spiral AC was then located by deflections.

Spiral was located A to H and from J to M with the 24-foot cord. The total deflection angle $d = 1^\circ - 25'$. The transit was set up at H, and the vernier was set at $I - d = 2$ deg. 50 min., and then turned on A, zero reading then gave line of the tangent at H, and the circular arc was then located as usual.

The spiral JM was located in the same way as the spiral at the other end, AH. In this connection I wish to say that our tables are arranged for 18, 24, 30, 36, 48 and 60 foot spirals.

I think there is already given enough formulas for the construction of tables necessary for use in locating easement curves in realignment work, and the formulas necessary for computing the easements are given without going into details. The transit work and the calculations are about as ordinarily performed in locating circular arcs.

As has been stated, the work of locating the spiral between the parts of compound curves is better performed by trial than by computation. In realignment work, the arcs of compound curves are necessarily located by trial. It is just as easy to locate spiral between compound curves in the same way.

In introducing a compound between a 2-degree and 6-degree curve for a 60-foot spiral, it would require 240 feet of spiral curve. Referring to the tables for deflections of a 60-foot spiral for 30-foot cords, if the spiral curve is located from the 6-degree curve the deflections will be the difference between the deflections for a 6-degree curve and that of a 60-foot spiral. If the spiral is located from the 2-degree curve, then the deflections are the sum of the deflections for a 2-degree curve and that of a 60-foot spiral.

From the 6-degree curve total deflections down to a 2-degree curve will be as follows:

Distance.	Deflections for an 8-deg. Curve.		Deflections for a 60-ft. Spiral, d.		Total Deflections.	Deg. of Curvature.
0+30	0—54	—	0— 1.5	=	0—52.5	5 deg. 30 min
+60	1—48	—	0— 6.0	=	1—42	5 " 00 "
+90	2—42	—	0—13.5	=	2—28.5	4 " 30 "
1—20	3—36	—	0—24	=	2—12	4 " 00 "
1—50	4—30	—	0—37.5	=	3—52.5	3 " 30 "
1—80	5—24	—	0—54	=	4—20	3 " 00 "
2—10	6—18	—	1—13.5	=	5— 4.5	2 " 30 "
2—40	7—12	—	1—36	=	5—36	2 " 00 "

Back deflections to turn on tangent 7 deg. —12 min. —2 deg. =7 deg. —12—3—12=4 deg. 00 min.

If the spiral is located from a 2-degree curve running up to 6-degree the deflections are as follows:

Distance.	Deflections of a 2-deg. Curve.		Deflections of a 60-ft. Spiral.		Total Deflections.	Deg. of Curvature.
30	0—18	+	0— 1.5	=	0—19.5	2 deg. 30 min.
60	0—36	+	0— 6.0	=	0—42.0	3 " 00 "
90	0—54	+	0—13.5	=	1— 7.5	3 " 30 "
1—20	1—12	+	0—24.0	=	1—37.0	4 " 00 "
1—50	1—30	+	0—37.5	=	2— 7.5	4 " 30 "
1—80	1—48	+	0—54.0	=	2—42	5 " 00 "
2—10	2— 6	+	1—13.5	=	3—19.5	5 " 30 "
2—40	2—24	+	1—36	=	4—00	6 " 00 "

Back deflections to turn on tangent =2+24+3—12=5 deg. 36 min. 3 deg.—12=2 deg.

CURVE ELEVATION.

By W. M. Camp.

In entering upon an investigation of the much-discussed subject of curve elevation the Committee proceeded on the ground that the question is necessarily complicated by widely prevailing abnormal conditions. It was therefore the aim of the Committee to report practice somewhat extensively, with only such generalizations as could be clearly deduced from the data submitted. In this undertaking the Committee was favored with 74 replies to a circular of inquiry bearing upon those particular phases of the subject which it was desired to investigate at this time. Nearly all of these replies were exceptionally full and carefully prepared as to definite points of information asked. The circular was generally distributed among maintenance-of-way officials, and the replies cover 60 different lines of railway or railway systems, 46 of which are prominent roads of the country, operating through passenger trains. So far as could be ascertained from the replies, 35 represent roads on which the principal traffic is freight, 11 represent roads on which the principal business is passenger traffic, and 19 represent roads handling a mixed traffic. The remaining 9 replies omitted mention of the class of traffic.

A principal object of the investigation was to ascertain to what extent the rules for curve elevation in force on various roads were derived from purely theoretical considerations. Out of the 54 replies bear-

ing on this point, 21 indicate that the formula for centrifugal force was used in deriving a general rule, but in nearly every case the rule so derived was modified to adapt it to practice. Thirty-three replies indicate that the rule in force was determined by trial, without mathematical consideration of the mechanical principles involved. Our information is therefore conclusive to the effect that in general practice the question of curve elevation is finally settled by experiment, to whatever extent the basis of the rule may rest upon theoretical calculation. Not less than 6 replies, covering in each case a large railway system, having a well organized engineering department, state that no rule or table for curve elevation is established, the matter being left to the judgment of the roadmaster or engineer in charge of each division.

The rule most largely in force (24 replies) for mixed traffic on level track is to elevate the outer rail 1 inch per degree of curve, up to a maximum of 6 inches of superelevation. In the instance of 10 replies the rate for similar conditions is ¾ inch per degree. For single-track mountain roads, where heavy grades prevail, a rate as low as ½ inch or ⅝ inch per degree of curve is extensively used, the maximum elevation in such cases being usually 3 to 5 inches. On roads where the conditions are such that the freight traffic may be disregarded, the rate of elevation for the passenger traffic varies all the way from 1¼ to 2 inches, and even 2½ inches, per degree, the preference seeming to lie equally with the 1¼ and 1½ inch rates. On several roads, however, it is the practice to introduce a constant additional to a rate varying uniformly with the curvature, as, for instance, in the practice of the New York Central & Hudson River Railroad, where the general rule for the elevation of main passenger tracks of 1 degree and over is 1 inch per degree plus 1½ inches, the maximum elevation being 6½ inches. On some other roads the rate is 1 inch per degree plus 1 inch. This arrangement provides a proportionally large elevation for the smaller degrees of curvature, which seems to be a principle extensively followed. The Philadelphia & Reading Railway makes use of a convenient rule, experimentally derived with the idea of maintaining a proper relation of curvature to speed, by which the superelevation is taken as the middle ordinate of a chord equal in length to the distance run by the express trains per second, the maximum elevation being fixed at 8 inches. The fast passenger service is given the greater consideration, notwithstanding that the principal traffic is coal and heavy freight.

Respecting the matter of maximum elevation preference seems to be decidedly in favor of 6 inches. On this question the Committee had 41 replies, 5 of which reported 5 inches, 1 reported 5½ inches, 23 reported 6 inches, 1 reported 6½ inches, 6 reported 7 inches, 1 reported 7½ inches, and 4 reported 8 inches. Practice in this respect does not seem to admit of ready generalization as to the class of traffic, for several roads operating express trains on fast schedule stop at a maximum elevation of 5 or 6 inches.

In general, two ideas are followed in elevating curves, one being to adopt rules covering typical conditions affecting the speed and then

apply such elevation as conforms to the rule; and the other is to estimate the elevation first applied, according to knowledge of the speed and traffic, and then observe carefully the riding of the cars and if necessary adjust the elevation until the cars ride satisfactorily. The latter method is the more common in practice. The speed used as the basis of trial or calculation for fast traffic is 55 to 60 miles per hour, more frequently 60 miles; for mixed traffic the speed is 30 to 50 miles per hour, more frequently 45 or 50 miles. It is seldom the case that the application of a rule for curve elevation is made hard and fast, variations being introduced to suit local conditions of grades and speed. Thus, for example, the elevation of curves on summits is usually less, and that of curves in sags usually more, than the customary elevation in vogue for curves of the same degree on level road. In the vicinity of stations, watertanks, unprotected grade crossings, draw bridges, etc., where stops are made or speed habitually reduced, there is also a decrease in the elevation. In some cases, also, where turnouts occur on curves the rule is not followed, the speed of trains being reduced at such places.

In the great majority of cases the rate of elevation determined upon is a compromise of the requirements of slow-speed freight trains and the speed of passenger trains. Thus, out of the 74 replies only 33 report giving the passenger traffic the preference, and in but very few cases is it given the sole consideration, in elevating curves. On the other hand, instances are still less numerous where the freight traffic is given the sole consideration, there being only four replies to indicate such practice.

The testimony of the replies as to the ill effects from heavy, slow-speed freight trains on curves fully elevated for fast passenger traffic is decisive and in numerous instances emphatic. Out of 59 replies bearing on this question, 48 mention one or more detrimental effects to track by reason of the disparity of the elevation as applying to the two classes of traffic. Nearly all report excessive wear to the inner rail, the canting of that rail, and abnormal cutting of the ties. Other objectionable results are the tendency of the track to constantly increase its elevation, owing to the disproportion of weight bearing upon the inner side of the curve, and the consequent displacement of the track in line and surface; the bending of tie-plates, as well as the creation of a necessity for the use of tie-plates. On the Philadelphia & Reading Railway (where the maximum elevation is 8 inches) the tendency of the inner rail to cant under the slow-speed trains is overcome "by the use of heavy tie-plates," but, according to the report, "they are not found to be necessary under the outer rail." There is also a remarkable tendency to derailment or capsizing of the cars, due to the tilting effect, which relieves the outer wheels of an undue share of the load, as the following quotations from the replies to the circular will show:

"On new roads this excessive elevation for slow, heavy freights develops low places on the inside rail, and cars already leaning heavily to that side swing over and take so much weight off the outside rail that new wheels mount that rail. I had frequent instances of this last year on a new division of the —— railway."

"There is a tendency for the load to raise the outer wheels and cause them to jump the track at bad joints."

"The principal traffic is freight, and on account of the sharp curvature the elevation is necessarily limited, on that account. If the elevation on our curves from 16 to 20 degrees is over 6 inches, and the speed of freight trains from any cause is reduced to from 4 to 6 miles per hour, derailments frequently occur."

"Excessive elevation makes the movement of slow and heavy trains difficult, reduces the tonnage rating of power, makes track maintenance costly, and the movement of top-heavy lading dangerous."

"It may sometimes be necessary to stop on a sharp curve, and if elevated for exceedingly high speed it might cause trouble. I have heard of a train stopping on a curve with some plate girders extending over three flat cars, and the girders fell over on account of elevation."

"The effect of slow-speed freight trains on track fully elevated for fast speed is very damaging to the track, both as to line and surface, sometimes causing derailment of freight cars. The excessive elevation also reduces the hauling capacity of freight engines on up grade."

"It is difficult after elevating curves for fastest passenger trains to keep track in line on curves where heavy, slow-speed freight trains are run."

Numerous replies also complain of increased train resistance from excessive elevation for slow-speed trains. We have the statement of the chief engineer of a mountain road to the following effect: "On our main line we elevate for a speed of 33 miles per hour, but on the ——— mountain grade our maximum elevation is only 3 inches, and we find that freight trains do better."

On the great majority of roads it is the practice in elevating curves to place the inner rail at grade and obtain all of the superelevation by raising the outer rail. While some admit that this arrangement effects a slight lifting of the entire grade throughout the curve, with a perceptible slight "lifting sensation," on entering or leaving the curve, there nevertheless seems to be no serious objection. Out of 74 replies to this question 56 report placing the inner rail at grade, 16 report that they obtain half of the superelevation by elevating the outer rail and the other half by depressing the inner rail, while only 2 report placing the outer rail at grade.

The most frequent rate of running out elevation at the ends of curves is 1 inch in 60 feet, such practice being reported by 22 replies, while 14 replies indicate a rate of 1 inch in 50 feet, 4 replies a rate of 1 inch in 40 feet, and 9 replies a rate of 1 inch in 30 feet. Scattering replies indicate rates varying all the way from 1 inch in 35 feet to 1 inch in 120 feet. Touching the matter of running out curve elevation it is clear that wherever fast speed assumes importance practice is fast changing in the direction of spiraling the ends of curves, thus making it possible to elevate with the curvature and maintain tangents level transversely their whole length. Out of 74 replies 57 report some form of easement curve. These curves take a variety of names as known to practice, mention being made of the Searles, Holbrook, Crandall, Talbot and Torrey spirals, the cubic parabola, tapering curves, and other transition curves not designated by particular names. Although these curves differ but little in geometrical

form, the name being applied principally to the manner of running out the curve, the preference seems to be decidedly with the Searles spiral, the Holbrook spiral coming next in order of preference, these two being mentioned more frequently than all others combined. In most cases the length of the easement is variable, according to the degree of the main curve or the height of the elevation, but in a few instances standard lengths of 100, 180, 200 and 300 feet are mentioned. In nearly every case it is the practice to run out the elevation with the easement, but some exceptions occur. The practice on the Michigan Central Railroad, as described by Chief Engineer A. Torrey, is as follows:

"It is our practice to give the transverse inclination, which is required for the first chord of the easement, to the tangents at the tangent points. I presume this is run out in half a rail length. It is our practice to give the full elevation for the curve, if it is a simple curve with easements at each end, at that point of the chord of the last piece of easement which is remote from the central curve. We have quite a lot of curves which in the original location were made up of two or more simple curves. It is our practice to join these simple curves, where they differ by more than 30 minutes in each 100 feet of curvature, by an easement similar in type to the easement at the junction of the tangents, but beginning at one end with the chord of slightly less radius than the chord it unites, and ending the easement with a chord of slightly greater radius than the chord it unites with. This naturally makes a rather complex system of superelevation in such instances, but is certainly worth all the trouble it involves to the engineer who has the location of this interior easement to stake out, and of the trackman who has to determine just where the changes in superelevation are to be made."

On the St. Louis & San Francisco Railroad the form of easement in use is a series of compound curves of 25-foot chords. The run-off starts with full elevation at the end of the main curve and extends onto the tangent 25 feet beyond the point of easement. The purpose of this arrangement is to obtain the full elevation for each chord of the easement curve as it is reached. While it is admitted that this method of running out the elevation is wrong in theory it is claimed that it produces better results than the usual method of elevating spirals.

Concerning this method as tried on another road the engineer states as follows: "Have tried commencing elevation half a chord length before reaching beginning of easement and obtaining full elevation the same distance before reaching P. C. regular curve, but could feel no difference in the riding of the cars, so I returned to the regular practice as being easier for section men to follow."

Five replies to the circular express a preference for curving the rails of spirals to correspond to the curvature of the spiral at the position of the rail. More specifically one informant replies as follows: "The rails for the easement should be curved for that portion of the same whose curvature exceeds that limit for which the rails are curved in general practice. The rails should be curved to the middle ordinate that will fit the degree of curve at the point where the middle of the rail will lie when in position. The ends, when coupled together, will

offset each other's strain and lie very nicely in the track to the position required."

On the question of elevating curved track in yards and sidings, 41 replies report that no elevation is practiced, while 25 replies report a reduced rate of elevation in such cases, 2 inches seeming to be a favorite maximum elevation. In a few instances the rate for sidings is half that for main line. In a single instance a rate of 1-16 to ⅛ inch per degree was mentioned.

It is important to recognize that the flange pressure of wheels against the outer rail of curves may be due to two forces, namely, the reaction of the wheel which ensues from being turned from a straight course, and centrifugal force due to speed. With proper elevation for the speed the centrifugal force may be counteracted, but the lateral pressure due to the tendency of the wheels to run in a straight line is always present. It is therefore impossible by any known arrangement to prevent flange pressure of wheels against the outer rail of curves. With a view to show that the elevation of curves does not overcome all objectionable features or elements of danger in curved track the Committee sought to find the collective opinion of maintenance-of-way officials by including in its circular of inquiry the following question:

"Do you consider properly elevated curves as safe as tangents, and, if not, in what respect do you think danger is to be looked for?"

To this inquiry there were 68 responses, 45 in the negative and 23 in the affirmative, the latter, however, in many instances, being qualified to include only moderate or very easy curvature. In the main the chief source of danger on curved track maintained in good alignment and surface and elevated according to approved standards is to be expected from defects in rolling stock. However, there is much opinion in support of the belief that certain tendencies to danger are inherent with the track itself, by reason of the curvature, and it can certainly be established that the development of certain defects to be looked for in curved track is promoted with increase in the curvature, independently of the elevation of the same. In support of these views we think well to submit a few typical answers to our circular of inquiry:

"I consider properly elevated curves up to 3 degrees as safe as tangents, but curves of 4 degrees and more are harder on rails, ties and rolling stock."

"Do not think curves as safe as tangents. A wheel with broken flange would run miles on straight line, but would hardly round a sharp curve."

"I do not think it possible to construct a curve of more than 1 degree that will be as safe as straight line, the principal danger being from defective rolling stock and improperly loaded cars. But I do think that a curve of 1 degree or less is probably just as safe, or safer, than straight line."

"No. Because the binding of cars on side bearings and defects in track, especially in connection with outer rail of curve, which, on straight track would cause no trouble, do cause derailments on curves."

"I do not consider properly elevated curves as safe as tangents. No matter how carefully a curve is elevated, the resistance of train to change of direction still remains. We must overcome this by stronger and

more perfect track than is required on tangent. The danger to be looked for is in defective rails, soft wood or poor ties, low joints, etc."

"I do not consider curves properly elevated as safe as tangents, and the greater degree of curvature, the greater the element of danger. There is a side strain on curves not found on tangents, which it is necessary to overcome before it is as safe as tangent. Danger, I think, will be in track spreading; more danger from broken rails and from defective trucks and flanges."

"Danger from curves is due mainly to worn rails, causing the wheel flanges to strike the splices, and from failure in some cases to properly adjust the gauge to the actual wheel base of the engines. Also, of course, to defective vertical and horizontal support of rails and irregular alignment."

"Properly elevated curves are as safe against danger from centrifugal force as tangents, but other reasons make them unsafe, the principal difficulty coming from the fact that the distance to be traveled on the outer rail is greater than that on the inner rail, and the wheels have to slip over towards the low rail. On mountain grades, where the rail has been sanded by a preceding train, we find a great deal of difficulty from the tendency of this sand to prevent the necessary slipping, and consequently the forward truck wheel climbs over the outer rail. The tendency to do this does not at all depend on the speed of the train, as it occurs quite as often at low as at high speeds."

"I do not consider properly elevated curves, or any curves, as safe as tangents. A derailment may be caused by much slighter derangements, or concurrence of a less number of abnormal conditions on a curve than on a tangent. I do not think, however, that a curve in the best possible condition is to be considered directly responsible for such an accident as above supposed, but that it is a condition to which it is not too difficult to add others, so that the combination leads to accident."

"I do not think any curve, however light, is as safe as tangent, and I believe the danger lies in derailment caused by insufficient bracing of outer rail, and also from lurching of improperly loaded cars while in motion across that portion of the tangent adjacent to the curve, upon which is made the run-off of the curve."

"I do not consider any curved track as secure from causing derailment as straight track. There is always some lateral pressure on the rails of curved track, and it is generally greater than the same kind of pressure on straight track. With this pressure always at hand, and in some cases very severe on the outer rail, any fault of the equipment passing over track, which is even in perfect condition, may put an obstacle on the track, and that obstacle, joined with the lateral pressure, may be such that a derailment may occur at a curve which would not be at all likely to occur on tangent. The flanged wheels of engines and the leading trucks of engines are variously arranged, and in some arrangements bring an undue strain on track, and wheel flanges, which may be forever innocuous on tangents, under the right conditions of wear of tire, flange and rail, may be very hazardous in the passage of a curve."

"I do not consider properly elevated curves as safe as tangents, for the reason that locomotives are not always properly counterbalanced for the speed they are required to make."

"In practice it is much more difficult to maintain curved track in as safe or in as good riding condition as tangents, this especially on roads handling mixed traffic. Heavy, slow trains disturb and strain the curves more than the tangents. As a rule, the curves are not as safe as tangents, because they cannot be maintained to proper elevation for all traffic, while tangents are level."

A question which has an important bearing upon the elevation of curves is the limitation of speed in relation to curvature. While it is well understood that no hard and fast lines stand in the way of the physical possibilities of speed on such curves as are in common service, there is nevertheless a decided and deeply-founded belief on the part of maintenance-of-way engineers that at certain limits of curvature, which fall within a maximum to be found on almost every road, the speed of trains should be restricted to reasonable limits. The basis of this opinion is that by reason of mixed traffic and liability to reduction in speed with even the fastest traffic, the ideal elevation of curves cannot be practiced. Assuming maximum elevation at 6, or even 8, inches, any of the customary rules for the fastest traffic cannot be followed beyond a comparatively low limit of curvature. In the circular of inquiry it was the aim of the Committee to draw out some expression of opinion on this matter, and although several did not wish to commit themselves to positive answers, the circular nevertheless elicited numerous responses. The question asked read as follows:

"At what limit of curvature do you think speed of 60 miles per hour should not be exceeded? State any reason you may have for this opinion."

Out of the 58 replies received, 1 placed the limit at 1 degree, 2 placed it at 2 degrees, 15 placed it at 3 degrees, 3 placed it at 3½ degrees, 21 placed it at 4 degrees, 1 placed it at 4½ degrees, 4 placed it at 5 degrees, 1 placed it at 5½ degrees and 10 placed it at 6 degrees. No reply favored a higher limit than 6 degrees. The weight of opinions is thus favorable to 4 degrees or less as the safe limit of curvature for speed exceeding 60 miles per hour. The reasons for these opinions are best explained by direct quotations from a few of the replies, as follows:

"Three-degree curve. It is not advisable, for practical reasons, to have a greater elevation of rail than 8 inches, and for 60 miles per hour this is about the superelevation for a 3-degree curve."

"From observation, I would say that speed of 60 miles per hour should not be exceeded on curves of over 3 degrees. The only reason I have for this is that I have gone around curves of 3 degrees at that rate of speed and felt very comfortable. In one or two instances I have gone at a higher rate of speed, and felt decidedly uncomfortable. This was due to the fact that the train was bearing too heavily, in my judgment, against the outside rail."

"I think 3 degrees should be the limit, because proper elevation cannot be given any sharper curves on account of slower trains. The elevation for a 3-degree curve for 60 miles per hour would be 8 inches, and I do not think this should be exceeded."

"I think a 4-degree curve, with 5-inch elevation, the limit of a speed of 60 miles per hour, and for curves sharper than that the speed should be reduced 5 miles per hour for each degree above the 4 degrees, i. e., a 6-degree curve should be limited to 50 miles per hour and a 10-degree curve to 30 miles per hour, and that is the rate of speed these curves will carry without the cars tilting outward to such an extent as to be appreciable to a passenger."

Four degrees. No particular reason, only I think there should be a limit to speed around curves. Have ridden engines around 4-degree curves at 60 miles per hour, and think it fast enough."

"Four-degree curve. We are now throwing out a curve on our —— division, known as "Dead Man's" curve. It is a 10½-degree curve, at the foot of a long 1½ per cent grade, and trains run fast down this hill. We had a special car thrown off a passenger train a year or two ago, and several prominent people were shaken up pretty badly. The track has been kept in good condition, but we have had several derailments there, although I do not think the trains ever ran over it as fast as 60 miles per hour. We are replacing it with a 4½-degree curve."

"Four degrees. I have not ridden over any track at a rate of 60 miles in which there were 3, 4 and 5 degree curves without being very conscious of them. My idea is that a person riding should not have his attention drawn to the track by reason of its inequalities, or that outward thrust experienced in going round a curve too fast."

"Do not see any reason why speed of 60 miles per hour should not be made on curves of 5 or 6 degrees if the track be properly elevated for that rate. On single-track roads the difficulty is found in adjusting the elevation to fit 60 miles downhill and 10 miles uphill."

"Four degrees is, I think, the limit of curvature over which trains should run at 60 miles per hour, especially if the track is intended to serve for both passenger and freight traffic. If for passenger traffic alone, I should say that curvature of 5 degrees could be maintained, so as to permit trains to run at a rate of 60 miles per hour. My reason for thinking the above-mentioned degrees of curvature maximum permissible in good practice for the rates of speed named, is that the elevation becomes so great that if trains should run as they at times necessarily do run, at considerably lower rate of speed, the track is liable to be thrown out of adjustment and there is possible the liability to derailment on account of the excessive bearing of wheels on the low rail, or in the overtipping of freight cars not symmetrically loaded in case they should be bumped or jerked in slow running or in stopping and starting."

"I think that a speed of 60 miles an hour should not be exceeded on a curve of over 4 degrees, on account of the danger of spreading track or the outer wheel flange climbing the rail at bad joints."

"I would limit the curvature at 6 degrees where the speed is 60 miles per hour. If the curve exceeds 6 degrees I would reduce the speed of trains."

"A speed of 60 miles per hour should not be exceeded on a 6-degree curve, as the required elevation would be too great."

"The —— and other mountain roads have a large number of 6-degree curves over which trains often make 60 miles per hour, but to go beyond this would increase the danger from broken axles or flanges. This may be illustrated as follows: Elevation required for 6-degree curve for slow freight, dragging uphill at 15 miles per hour, is 1 inch. Same curve for fast passenger coming down grade 60 miles per hour requires 15 inches. The compromise elevation usually given is 6 inches. Excess of elevation for freight, 5 inches; deficiency in elevation for passenger, 9 inches. While this 5-inch excess elevation for the slow train is almost great enough to throw such a proportion of the weight on inner rail that the friction of the tread of inner wheel is liable to overcome friction of flange on outer rail and thus derail the train, the 9-inch deficiency of elevation in this same curve for the fast train throws such a large proportion of its weight laterally against the outside rail that the danger point cannot be far off."

The information reviewed by the Committee in making this report seems to support the following recommendations, which we offer for the consideration of the Association, hoping that any points found to be in dispute may be accorded the benefit of a full discussion:

1. The range of the application of the usual formula based on centrifugal force ($g\ V^2 \div 32.2\ R$) is so limited that it is practically of no value for the calculation of general rules for curve elevation. The logical and only practicable method of determining rules for curve elevation to meet the conditions of practice is by trial, with typical examples of curvature and speed, adjusting the elevation until the trains ride satisfactorily.

2. Adopting the method of trial, any formal consideration of the speed of trains is immaterial, since if the trains ride satisfactorily on the elevation determined by this method the object sought is fully accomplished.

3. The following approximate rules cover typical classifications of traffic sufficiently well to be safely followed until trial under the local conditions may determine necessary modifications:

(a) For heavy freight traffic, elevate at the rate of ¾ inch per degree, up to a maximum of 5 inches.

(b) For mixed traffic, elevate at the rate of 1 inch per degree, up to a maximum of 6 inches.

(c) For fast passenger traffic, where the freight traffic may be disregarded, elevate at the rate of 1 inch per degree, plus 1 inch, up to a maximum of six inches.

(d) If the curvature be such that more than 6 inches would be required by following the rule in any of the above cases, the speed should be reduced rather than exceed the adopted maximum elevation.

4. The inner rail should be placed at grade. While it is possible to demonstrate some advantages for placing the track at grade on center line, the depression of the lower rail introduces some difficulties into the work of maintaining proper surface at the ends of the curves.

5. The only satisfactory method of running out curve elevation is in connection with the use of easement curves. The track at the point of easement should be level transversely, and the elevation for the curve should be developed with the easement, reaching full elevation at the end of the easement or beginning of the main curvature. If the conditions of location will permit, the length of the easement should be such that the elevation may be run out at the rate of 1 inch per 30 to 60 feet of easement.

6. Speed as high as 60 miles per hour should not be made on curves sharper than 4 degrees.

MAINTENANCE OF GAUGE.

By C. L. Addison.

Proper Method of Spiking.—In considering the subject of gauge, it seems pertinent to call attention to the necessity of having properly constructed tools.

The track gauge is the most important tool furnished the trackmen and its accuracy is of such importance that it is considered desirable to test all gauges before issued. It is of equal importance that the length of the tool remains constant.

To insure this quality, the crossbar should be of material not subject to change of length through rough or careless handling.

In use the gauge should be placed squarely across the track and the rail to be gauged held firmly against the head of the gauge.

Outside spikes should be started first and both outside and inside spikes driven at the same time, with faces of spikes in contact with and parallel to the base of the rail.

The gauge should remain upon the rails until the spikes are fully driven.

The final blow in driving should be just sufficient to bring the head of the spike in contact with the base of the rail without straining the head of the spike.

To prevent the tie from assuming a position at an angle with the rails, the system commonly known as "cross-spiking" should be employed. The outside spikes of both rails should be on the same side of the center line of the tie and the two inside spikes on the opposite side.

Spikes should be started at right angles with the tie, and this position should be maintained during driving. The practice of straightening up spikes which have been partly driven at an angle should be discouraged. This "straightening up" not only bends the spike, but compresses the fibre of the timber, causing an enlargement of the spike hole. This is particularly noticeable where comparatively soft wood ties are in use, and practically destroys the power to resist lateral or vertical pressure.

Methods Used to Prevent Spreading of Track and Canting of Rails.—On account of the shortness of time, replies from only 25 roads have been received in answer to the above subject.

Of the roads replying to the questions, it would appear that 44 per cent of these roads use tie-plates, 32 per cent use tie-plates and rail braces, and 12 per cent use rail braces only, to prevent the canting of rail and consequent widening of gauge.

Of the remaining 12 per cent, one road uses inside guardrails to hold off the wheels and reduce the lateral pressure at point of flange contact. Another road adzes the surface of the ties under the rail, so as to cant the rail toward the center of the track. Other roads double spike the outside of the rail, and one road replies that the canting of rails has never been observed.

The forces which tend to widen the gauge of tracks at curves are of two kinds:

First, lateral thrust, considered simply as lateral thrust; due to the pressure exerted by the wheel flange upon the rail at the point of contact; caused by centrifugal force, augmented by the sway of imperfect equipment. So considered, and assuming no change in the surface of the tie under the rail, this force is readily resisted by the outside spikes, on curves

of large radius, and by the spikes, reinforced by rail braces on curves of smaller radius. This presupposes the use of ties of hard or moderately hard woods.

The second, and, by far, the more destructive force, is the resultant of the vertical load on the head of the rail and the above-mentioned horizontal or lateral force acting at the point of flange contact.

The resultant force acts in the direction of a line, extending, approximately, from the inside edge of head to a point somewhere between the center of the rail and the outside edge of the base; depending upon the speed of the train and the amount of elevation of the rail.

As a result of this force, the fibre of the tie immediately under the rail is compressed to the greatest extent at the outside edge of the base of the rail.

In combination with the sawing action of the rail on the tie, due to the undulatory movement of the rail, the destruction of fibre takes place with greater or less rapidity, depending upon the degree of hardness of the tie. As the destruction of fibre is greatest at the point of greatest pressure, it is obvious that as the rail cuts into the tie, the rail will assume a canted position and the original gauge of the track will be widened. As before stated, the rail brace satisfactorily resists lateral thrust only, but absolutely fails to resist the canting of the rail. The same forces which tend to cut away the tie under the outer edge of the rail depress the portion of the brace in contact with the rail, raising the outer end and drawing the spikes. As a matter of fact, immediately the cutting of the tie commences the rail brace becomes a lever of the first class, with its fulcrum on the tie, near the outer edge of the rail. The weight is the wheel load and the power, the holding power of the spikes. The power arm, as far as two of the spikes are concerned, being practically the same as the weight arm of the lever. It is obvious that rail braces in this capacity must fail absolutely. The properly designed tie-plate is the only known device which will prevent the cutting of the ties and the consequent canting of the rail, and, in addition, prevents the outward movement of the rail due to lateral thrust by bringing into use the inside spike to resist this action. To secure the best results tie-plates should be used on *every* tie in the curve. We do not consider the practice of tie-plating every second or third tie desirable, inasmuch as the unplated ties, in offering less resistance than the plated ones, subject the rail to an unusual torsional strain between the plated ties. It is respectfully recommended that curves of 3 degrees and upwards be tie-plated, using tie-plates on every tie, and that all soft-wood ties in curves of any degree be plated. By so doing the resistance offered by the plated soft tie approximates the resistance of the unplated hardwood tie.

Widening of Gauge on Curves.—With regard to the widening of gauge of track at curves, no uniform practice can be said to exist on American railroads.

In response to circular No. 16, replies have been received from 25 roads, representing 47,600 miles of line. Condensed summary of the practice of these 25 roads as follows:

PRACTICE OF 25 AMERICAN ROADS IN WIDENING GAUGE OF TRACK ON CURVES.

Roads.	Increase commence with	Range of increase	Maximum increase.
1	12°		$\frac{3}{4}''$
1	8°	For 1° inc. $\frac{1}{32}$	1''
2	6°	" 1° " $\frac{1}{16}$ to $\frac{1}{8}$	$\frac{1}{2}''$ and $\frac{3}{4}''$
1	5°	" 1° " $\frac{1}{16}$	$\frac{1}{2}''$
1	4°–30′	" 1° " $\frac{1}{32}$	$\frac{1}{2}''$
6	4°	" 1° " $\frac{1}{32}$ to $\frac{1}{2}$	$\frac{1}{4}''$ to $1\frac{1}{4}''$
5	3°	" 1° " $\frac{1}{32}$ to $\frac{1}{2}$	$\frac{1}{2}''$ to 1''
1	2°	" 1° " $\frac{1}{16}$	$\frac{1}{2}''$
1	1°	" 1° " $\frac{1}{24}$	$\frac{1}{4}''$
6	No increase.		

At a meeting of the American Railway Association, held in New York, October 6, 1897, the report of the Committee on Standard Track and Wheel Gauges contained replies from roads aggregating 94,276 miles of line.

The condensed summary of practice of 104 roads, in widening gauge of track on curves, from "Engineering News," as follows:

TABLE NO. 2.

Roads.	Increase commencing with	Range of increase.	Maximum increase.
18	1°	1° inc. $\frac{1}{32}''$ to $\frac{1}{4}''$	$\frac{1}{4}''$ on 5 roads
5	2°	2° " $\frac{1}{16}''$ to $\frac{1}{4}''$	$\frac{3}{8}''$ on 2 "
15	3°	3° " $\frac{1}{16}''$ to $\frac{3}{8}''$	$\frac{2}{5}''$ on 1 "
10	4°	4° " $\frac{1}{16}''$ to $\frac{1}{2}''$	$\frac{1}{2}''$ on 30 "
16	5°	5° " $\frac{1}{16}''$ to $\frac{1}{2}''$	$\frac{5}{8}''$ on 5 "
7	6°	6° " $\frac{1}{8}''$ to $\frac{1}{2}''$	$\frac{3}{4}''$ on 24 "
3	8°	7° " $\frac{2}{16}''$ to $\frac{21}{32}''$	$\frac{9}{16}''$ on 2 "
1	9°	8° to 9° " $\frac{1}{8}''$ to $\frac{3}{4}''$	$\frac{15}{16}''$ on 2 "
2	10°	10° to 12° " $\frac{1}{8}''$ to 1''	1'' on 8 "
1	13°	13° " $\frac{1}{8}''$ to 1''	$1\frac{3}{16}''$ on 1 "
1	21°	14° to 20° " $\frac{1}{4}''$ to 1''	
25	No increase of gauge on curves.		

Of the 94,276 miles of line reporting on this subject:

16,239	miles	report	no increase of gauge on main track.			
307	"	"	increase from	12°	upwards.	
4,117	"	"	"	"	8°	"
2,967	"	"	"	"	6°	"
3,331	"	"	"	"	5°	"
25,387	"	"	"	"	4°	"
19,111	"	"	"	"	3°	"
7,307	"	"	"	"	2°	"
15,510	"	"	"	"	1°	"
94,276						

The variation in practice, as shown by Tables 1 and 2, is undeniably great. While it is impossible to establish a rule for gauge-widening which will apply in all cases, good practice does not seem to warrant such great variation as shown.

Since it is the locomotive, differing in length of wheel-base and truck arrangement, which determines the amount of widening of gauge, as well as the rate of widening, it may be proper to quote from the reports of the American Railway Master Mechanics' Association for 1899 and 1900, in order to establish the figures used in subsequent calculations.

The practice of flanging all drivers of the ten-wheel Mogul and Consolidation type of engines is gaining favor with the heads of mechanical departments and has been reported upon favorably by the committee on the subject. The extent to which this practice has been carried, from report of 1899, as follows:

Number of engines owned by roads replying, 12,265.

Mogul type.....	1,183
10 Wheel type.....	2,284
Consolidation type.....	2,066
	5,533

All drivers flanged.	1st and 3d flanged.	2d and 3d flanged	1st and 4th flanged.	1st, 3d and 4th flanged.	Total.
Mogul..... 440	743	.....	.....	.....	1,183
10 Wheel.... 534	1,048	702	.....	.....	2,284
Consolidation 348	.....	.....	1,313	405	2,066
1,322	1,791	702	1,313	405	5,533

Longest rigid wheel base.		Longest total wheel base.	
All flanged.	Partly flanged.	All flanged.	Partly flanged.
Mogul..... 16 - 1½	16′ - 0	23 - 0′	23′ - 10½′
10 Wheel ..... 14 - 1	16 - 0	24 - 10	26′ - 6
Consolidation... 16′ - 3″	16′ - 3″	24′ - 2″	24 - 6′

"*Swing motion* trucks are used with the three types of engines having all tires flanged, the motion being 1½ inches each side of the center.

"Same practice prevails with Mogul, Consolidation and many ten-wheel engines haveng tires *partly* flanged, but about *50 per cent* of the ten-wheel engines with tires *partly* flanged have *rigid* trucks.

"In all types the practice when the above classes of engines leave shops is to have lateral motion of ⅛ inch in each driving box and same lateral in each engine truck box. With tires partly flanged, the distance between backs of flanges for each type of engine before mentioned appears to be 4 feet 5¼ inches.

"In cases of engines having flanged tires on all driving wheels the same practice prevails for Mogul and ten-wheel engines. Practice with Consolidation engines having flanged tires on all driving wheels is to

have the distance between flanges of 1st and 4th pairs of wheels 4 feet 5⅛ inches and between the backs of flanges of 2d and 3d pairs of wheels 4 feet 5¼ inches."

As will be seen from the first part of the report, 50 per cent of all ten-wheel engines with partly-flanged drivers now in service on American roads are equipped with rigid trucks. This class of engine, as well as the standard eight-wheel type, which, in many cases, is equipped with rigid truck, constitute the limiting engines in the consideration of gauge widening. Consolidation, Mogul and ten-wheel types with drivers all flanged are invariably equipped with swing trucks and would constitute limiting types if the swing motion is not sufficient. As the Master Mechanics' Association recommend 1½ inches swing motion, it is presumed that this distance is not to be exceeded and unless 1½ is enough to allow the truck sufficient motion to permit the leading driver flange to touch the outside rail, a condition the Master Mechanics wish to avoid, these engines will become a limiting class and the values of quantities entering into the formulas suggested by Mr. William H. Searles in Engineering News of Dec. 2, 1897, will have to be modified from those shown on accompanying diagrams to meet the requirements imposed by all-flanged drivers.

In quoting from the reports of the Master Mechanics' Association it is not intended to convey the impression that the roadway departments are in sympathy with the movement to save flange wear at the expense of the track.

Engines of the types mentioned above are in service to the extent of 20 per cent, and the use cannot be considered general.

In dealing with the subject of gauge widening, these engines have not been considered as constituting a limiting class, and, inasmuch as the proper values have not been introduced into the formulas to meet the requirements imposed by all-flange drivers, the report is necessarily incomplete.

The formulas referred to above, as suggested by Mr. Searles, are formulas for the degree of a curve, having given either the middle ordinate and chord or a side ordinate at a given distance from the middle of the chord and its chord, based on the well-known approximate formula $m = \frac{C^2}{8R}$

In applying these formulas to the formation of the accompanying diagrams, Nos. 1, 2 and 3, it has been considered desirable to calculate the radius rather than the degree of the curve, thereby avoiding a second approximation. The formulas used, as follows:

$$\text{For rigid truck } R = \frac{6\,a\,b}{p} \qquad (1)$$

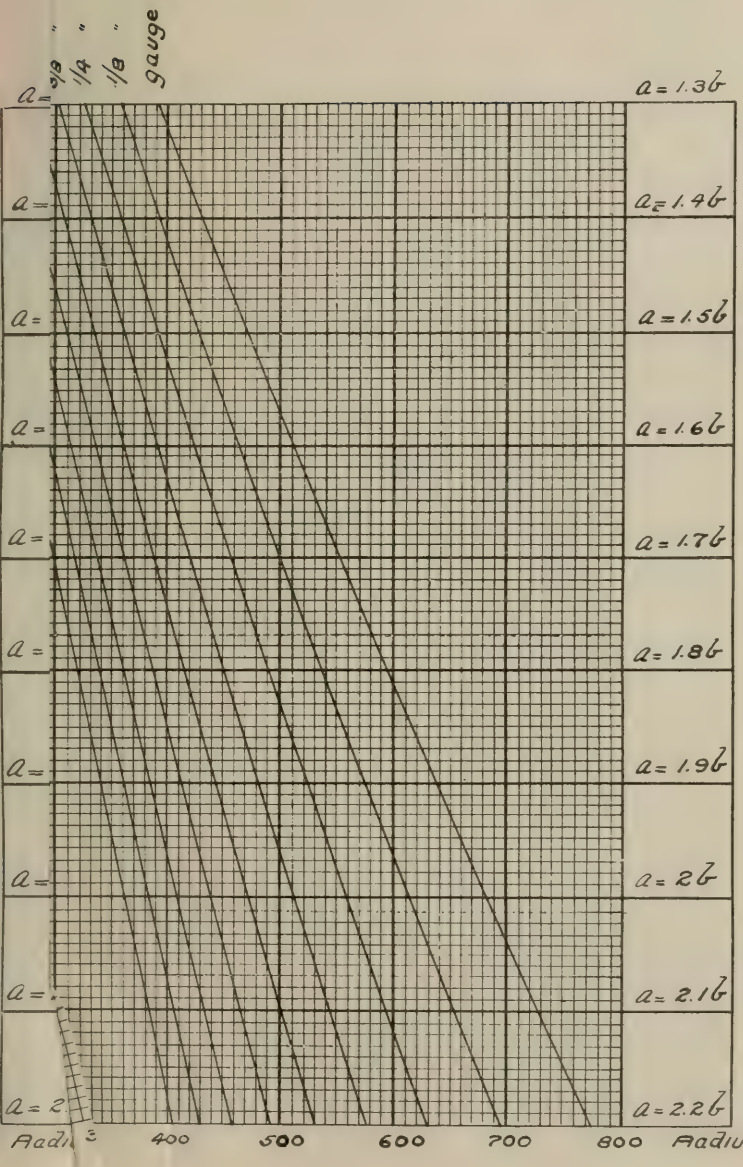
$$\text{For swing motion truck } R = \frac{6\,a\,b}{p + \left\{\frac{s\,b}{a+b}\right\}} \qquad (2)$$

in which a represents the distance from the center-pin of a four-wheel truck or the center of the axle of a two-wheel truck to the center of the front-flanged driver axle expressed in feet.

$$\text{Radius} = \frac{6ab}{p + \left(\frac{sb}{a+b}\right)}$$

C.

Flange play - p - = .625 in.
Side motion - s - = 1.5 "



For locomotive with swing truck

Radius = $\frac{6a^2}{p+\left(\frac{3s}{a+b}\right)}$

Flange play $p = .625$ in.
Side motion $s = 1.5$

A.

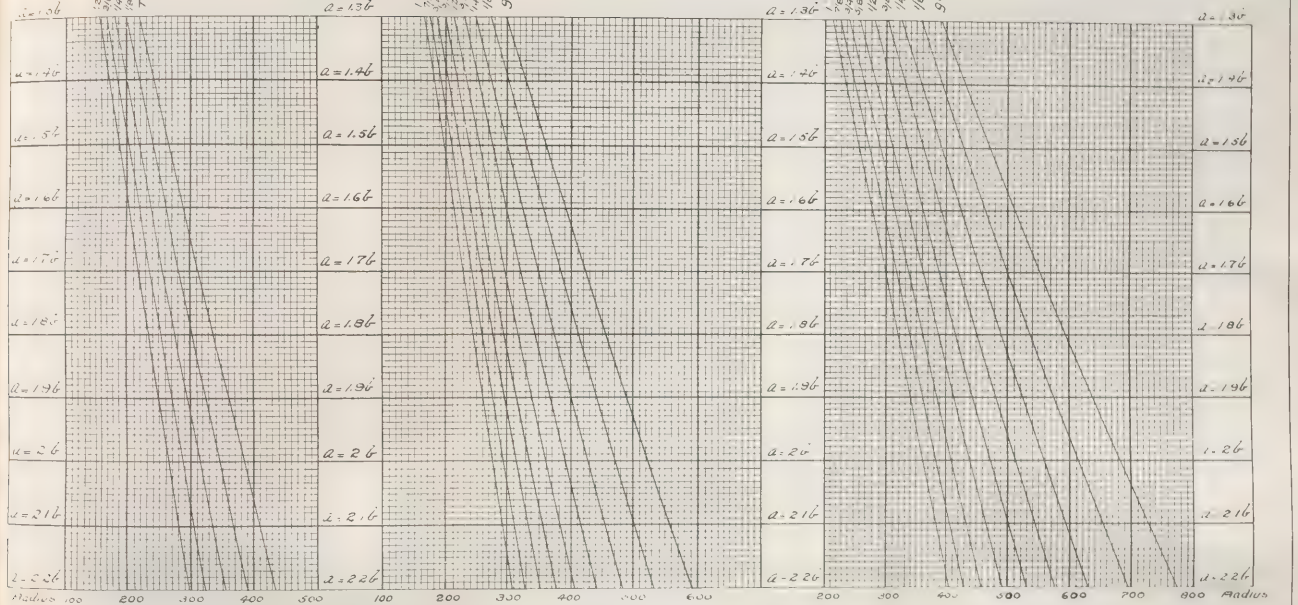
$b = 6$ feet

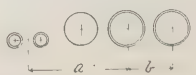
B.

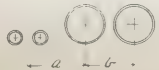
$b = 7$ feet

C.

$b = 8$ feet



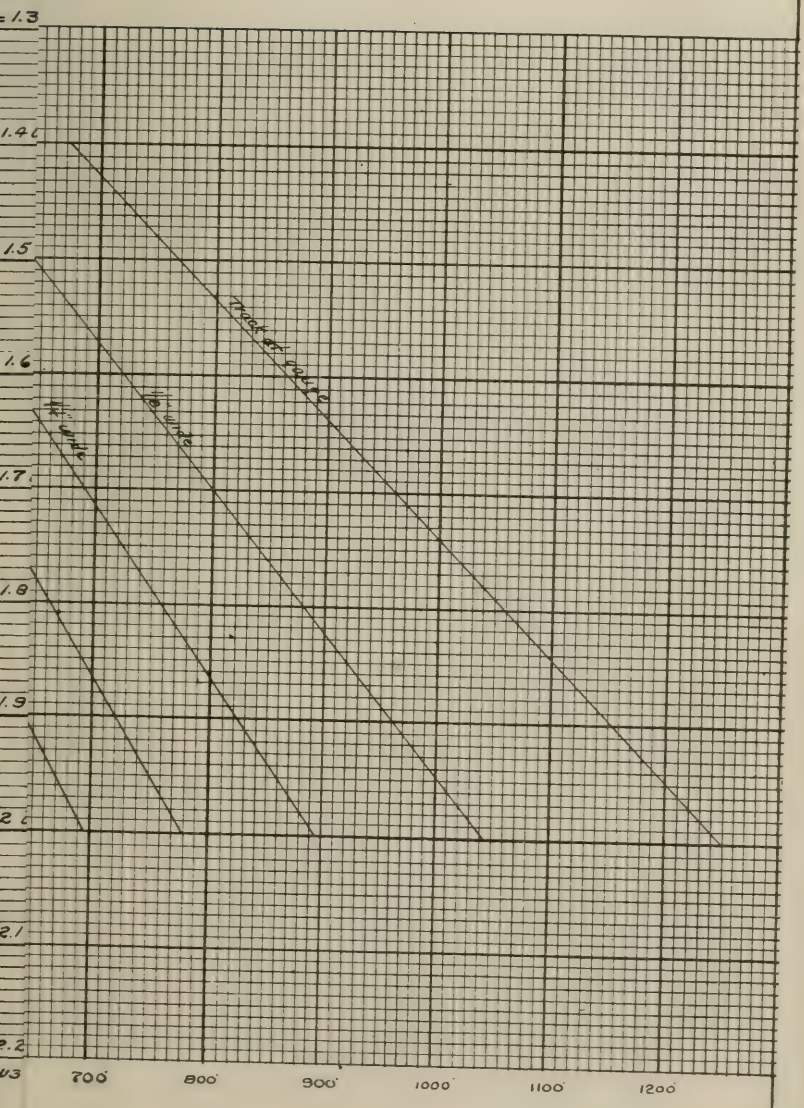




Locomotives with Rigid trucks

$$\text{Radius} = \frac{6ab}{p}$$

$p = .625$ inches.

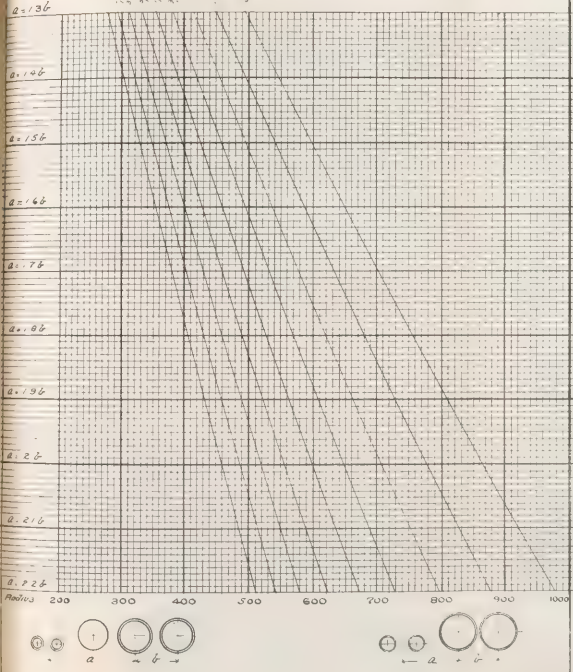


For Locomotives with swing trucks

$$\text{Radius} = \frac{6a^2}{p + \left(\frac{3E}{4D}\right)}$$

When b = 9 feet

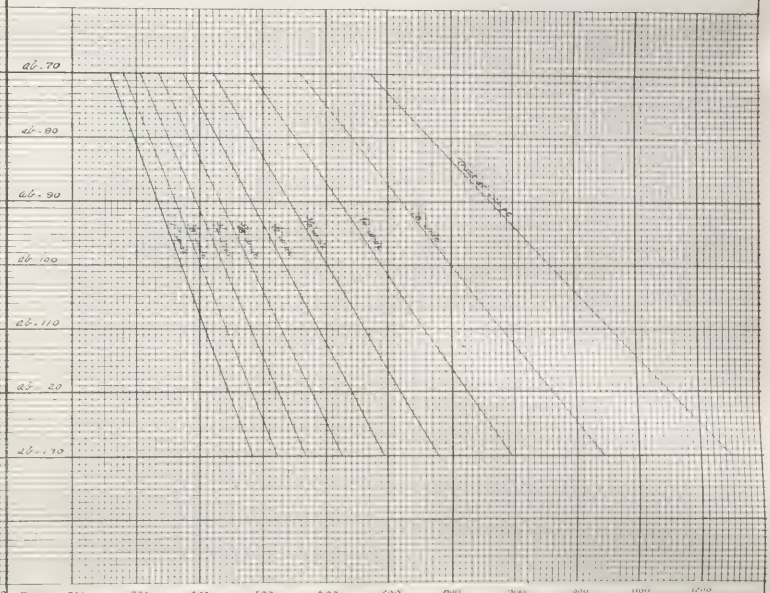
Flange play p = .625"
Side motion s = 5"



For Locomotives with Rigid trucks

$$\text{Radius} = \frac{6a^2}{s}$$

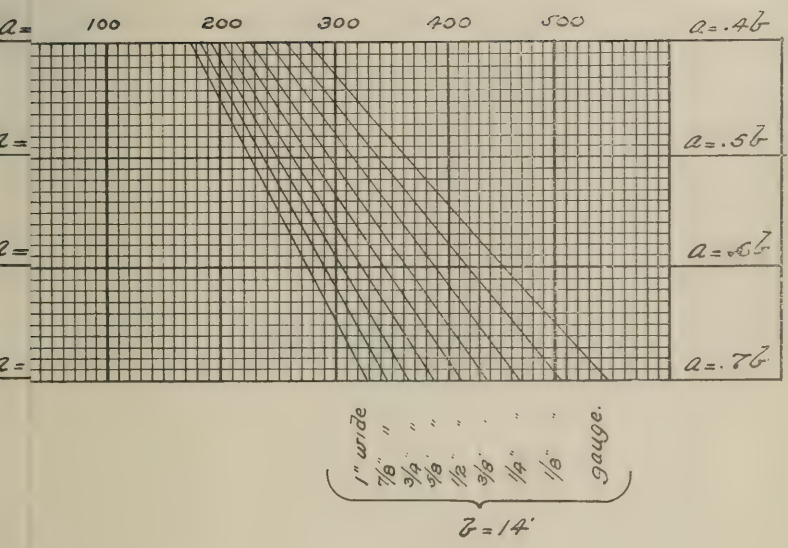
p = .625 secs



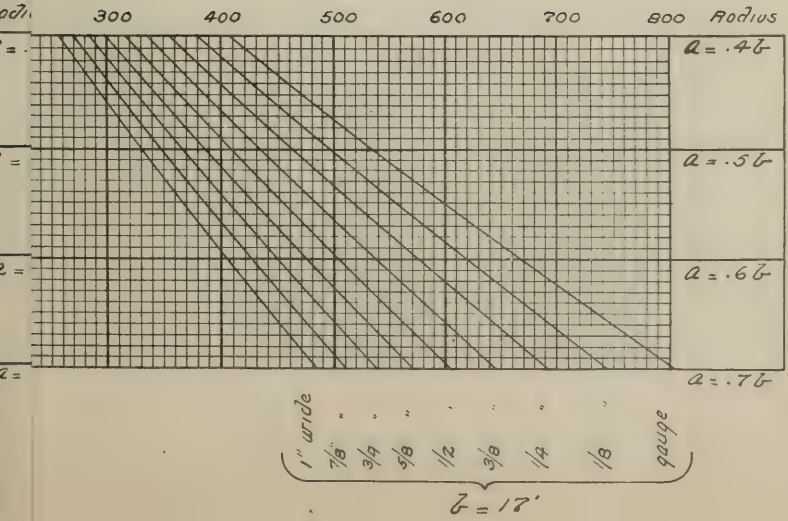
$$\text{Radius} = \frac{6ab}{p + \left(\frac{sb}{a+b}\right)}$$

Flange play "p" = .625 inches.
Side motion "s" = 1.5 inches.

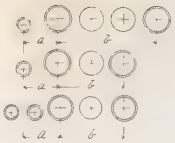
C.



F.



For locomotive with swing truck



A.

B.

C.

D.

E.

F.

b represents the distance from the center of the front-flanged driver axle to the center of the rear-flanged driver axle, expressed in feet.

p, the flange play, including the widening of gauge, if any, in inches. Assumed as ⅝ inch for flange play.

s, the side motion in inches assumed as 1½ inches.

In constructing the accompanying diagrams it has been assumed that ⅝-inch flange play and 1½ inches side motion are minimums, and it is thought that by the use of the above minimum values the radii shown on the diagrams will allow sufficient play for an engine to move freely through the curve.

These diagrams have been constructed for track at gauge and also for gauge widened at rate of ⅛ inch up to 1 inch maximum widening.

For engines equipped with rigid truck formula (1) $R = \frac{6\,a\,b}{p}$ is used as before stated. An examination of the plans of 40 eight and ten-wheel engines constructed for 20 different roads during the last four years shows that the product of a and b in these engines varies from 70 to 124. (See diagram 2, right side.)

To illustrate, assume an eight-wheel passenger engine, distance from center of truck to first driver, 12 feet; distance between drivers, 7 feet. Product of a and b in this case is 84. Diagrams show that this engine with track at gauge should pass around curve of 797 feet radius, or, approximately, 7 degrees 10 min., and with track 1 inch wide gauge, should pass around curve of 307 feet radius.

Diagram 1 and diagram 2 (left hand) have been constructed for eight and ten-wheel engines with swing trucks, using formula (2) $R = \frac{6\,a\,b}{p + \left\{\frac{b\,s}{a+b}\right\}}$

As the value of the denominator is dependent upon b in this case, diagrams have been constructed for certain values of b and for certain relations between a and b. If the engine with rigid truck before described, be equipped with a swing truck, the distance a and b being respectively, 12 and 7 feet, as before, the curve around which this engine will pass will be found from diagram B, sheet 1, where b equals 7 feet. With $a = 12$ feet and $b = 7$ feet, $a = 1.7\ b$. Referring to diagram 1-B, it will be seen that this engine with swing truck will pass around curve of 430 feet radius with track laid at gauge, and around curve of 230 feet radius with curve 1-inch wide gauge. An examination of the plans of the 40 engines before mentioned show that the distance (a) from the center of truck to the first flanged driver axle varies from 1.3 to 2.2 times the distance (b) between flanged drivers.

An examination of the plans of Consolidation and ten-wheel engines shows that the distance between extreme drivers varies from 12 to 17 feet, and that the distance (a) between the center of truck-wheel axle and first flanged driver axle varies from .4 to .7 of the distance (b) between the first and last flanged driver axles. Diagrams 3A, 3B, 3C, 3D, 3E and 3F constructed for Consolidation and ten-wheel engines.

Assume Consolidation engine distance (a) between center of truck axle and the center of first flanged driver axle 8.5 feet, and distance (b) between center of first and last flanged driver axles 15 feet. In this engine the distance between center of truck axle and first flange driver axle is approximately .56 times the distance between extreme flange driver axles. Referring to diagram 3B for b = 15 feet, it will be seen that for a = .56 b this engine will pass around a curve of 485 feet radius when track is laid at gauge and around a curve of 295 feet radius when track is laid 1 inch wide gauge.

In conclusion, the attention of the Committee is called to the fact that any table for the widening of gauge on curves will not be applicable to all classes of engines. A glance at the accompanying diagrams will clearly show this to be a fact. Inasmuch as every railroad is running over its lines some engine which can be considered as a limiting engine, it must follow that each road will be obliged to establish a system of gauge widening peculiar to itself.

INSPECTION OF TRACK.

By S. B. Fisher.

There are reports from only 23 roads. While the reports are not as numerous as we would like, nor as full and specific in some cases as we would desire, they come from all parts of the country, excepting from the Pacific Coast. They come from long roads and short roads, from roads where traffic is thick and heavy, where it is medium and where it is light. They apparently give a fair summary of the current practice between the Atlantic Ocean and the Pacific Slope.

Track Walking—When Resorted To.—With three-fourths of the roads this is required daily. A very few roads require detailed special inspectors to patrol the track constantly. One road in the Northeast requires in its regular routine a semi-daily inspection of track during the winter months. Very few roads, and these with thin traffic, require inspection only every two days. Several require inspection on six days, omitting Sunday. The great majority of roads, however, require a daily inspection, this inspection to be made by the section foreman and his gang over the portion of the road which they traverse going to work, and by a man detailed to patrol the portion of road which they do not go over on that day.

A number of roads with medium traffic do not require regular track walking in fair weather, but all require it during and after storms. Many roads require track walking during storms at night. All roads which run along the foot of bluffs, so far as heard from, require special track walking during thaws and rains.

Track Walking—Particular Requirements Of.—Track walkers are required to inspect, first, and most of all, the track, and, secondly, the right-of-way, fences, etc.

The track walker is required to have a spike maul, wrench and train signals, and any other special tool or appliance required. He is required to look for broken rails and ties, to look for spikes loosened or broken,

to note especially the joints, to replace bolts when out of joints, to tighten loose bolts, to replace and secure shims and to clean public road crossings. He is required to remedy small washings of roadbed and to drain small puddles of water in the ditches. He is required to put stock off the right-of-way, when found, and to repair the fence: in short, to fix up anything that is amiss, when he can do it without much loss of time or labor, and when the trouble is at all serious to report to section boss or other agent of the company.

Special Inspection of Switches, Frogs, Crossings, Derailing Points, Interlocking Plants, Etc.—Requirements.—All roads require special inspection of frogs, switches and crossings; most roads require it daily in the morning. Several roads require weekly inspection by section foreman. Many have periodical inspection by supervisor, superintendent or engineer of maintenance-of-way. Only one or two roads report definite standards to guide these inspections. Nearly all roads seem to have regular, or irregular, general inspection of some kind for frogs and switches in addition to inspection by section forces.

The majority of roads do not appear to have derailing points and interlocking plants enough to say what they do about them. The ones that do only require a casual inspection from track walkers or section force, requiring them to remedy trivial or rough defects, and having a skilled mechanic or special inspector to attend to them.

Inspection of Bridges, Trestles, Culverts, Etc., by Trackmen.—All roads require some kind of inspection of bridges, trestles and culverts by trackmen. Some require it weekly and some daily. Nearly all roads require trackmen to keep culverts free from obstructions, and to keep inflammable material of any and every kind away from wooden structures. All roads require trackmen to either make right or report any damage or danger to bridge and trestles during or on account of storms, floods, thaws or accidents from any cause. Most roads do not rely much on section men in maintenance of bridges and trestles, but trust to their bridgemen.

CROSSINGS.

By W. H. Kimball.

A, Foundations and Drainage. B, Types.

The following is the practice on the roads named below:

Buffalo & Susquehanna Railroad.—Square timbers, 12x16 inches, on gravel. Natural Drainage. "If crossing is less than 9 or 10 degrees, movable points should be used."

Chicago, Milwaukee & St. Paul.—A, gravel and stone ballast. B, reinforced.

Chicago & North-Western Railway.—B, for large angles and heavy traffic. Easer rails entire length. For light angles only near the angles. For light traffic not at all. Framed timber not used. Ties for all angles. Wrought-iron fillers. Filled and bolted crossings. No plates. One-inch bolts for heavy rail.

Chicago, Rock Island & Pacific Railway.—B, bolted crossing. Wrought fillers. Easer rail. Five-eighths-inch plate under each angle to get better bearing on ties and act as a binder. Ties usually set at right angles to line having greatest traffic. For angles between 50 and 90 degrees, framed oak timbers, 8x14 inches. Under angles of 50 degrees, ties, bisecting crossing angles, 7x9-inch oak. A, crushed rock and tile when necessary.

Denver & Rio Grande Railroad.—A, cinders and decomposed granite. B, home-made.

Georgia Railroad.—A, crushed stone. Drainage obtained as in other parts of track. B, various.

Houston & Texas Central Railway.—A, 12-inch ballast. 7x10-inch ties. B, bolted with guard rails.

Illinois Central Railroad.—B, over 60 degrees, Easer rails entire length. Prefer ties to framed timbers, even on 90-degree crossing angles. Use bolted crossings and do not consider it any advantage to use plates. Wrought-iron or steel fillers. Large bolts. Heavy outside angle irons.

Kansas City, Fort Scott & Memphis Railroad.—"Usually build surface crossing angles, supported by 12x12-inch timbers, on ballast. Only use double traffic rail in special cases."

Lake Shore & Michigan Southern Railway Company.—B, all with Easer rails. No framed timbers used, but 7x10-inch ties laid diagonally. Rolled steel fillers. Bolted crossings. Nothing less than 1-inch bolts.

Michigan Central Railway.—A, Broken stone for foundation, and if ground requires it, tile drains. B, all kinds.

Missouri, Kansas & Texas Railway.—A, ordinary ties on ballast. Bisecting angle. B, bolted, rigid crossing.

Nashville, Chattanooga & St. Louis Railway.—A, on heavy cross-ties, placed diagonally so as to give the best support to both tracks. B, no special type of construction. Bolted with cast-steel fillers, riveted to plates. Joints square and mitered according to angle.

New York Central & Hudson River Railroad—A, one foot stone ballast, with necessary provision for drainage, depending upon location. Where necessary drain tile is used. B, for main track crossings. Easer rails, both tracks; for unimportant crossings and street car crossings, no Easer rail except on steam track.

Bolts for 60-lb. and 70-lb. rail.	$\frac{7}{8}$ in	Plates at angles fastened to rail by clips.
" " 75-lb. rail.	1 "	
" " 80-lb. "	$1\frac{1}{8}$ "	
" " 100-lb, "	$1\frac{1}{4}$ "	

Philadelphia & Reading Railway.—Small angles 45 degrees and under. Large angles 45 degrees to 90 degrees. Plate riveted under each throat. Wrought fillers for small angles and Easer rail. For angles from 11 degrees to 26 degrees wings to be bent at angle, *not* jointed. Easer rails for large angles. For 80-pound and heavier $1\frac{1}{8}$ inches. Under 80 pounds, 1-inch bolts. Plates $\frac{3}{4}$-inch thick. In cross-paved streets white

oak framed timbers 10x16 inches. If a groove is cut through head of steam rail, it must not exceed 13-16 inch.

Peoria & Pekin Union Railway.—A, "we do not use any special means of draining, as we find cinder ballast sufficient. Our experience with tile drains has been that the action of the crossing churns the mud, causing tile to fill and block drainage." All crossings laid on ties. B, our crossings are of 80-pound rail, reinforcing rails and 1-inch bolts with jam nuts.

The following points are open to discussion:

Should ties or framed timbers be used? If ties, should they be laid bisecting the angles, or at right angles to line having the greatest traffic?

Are crossings laid on framed timbers more liable to creeping action under traffic than if laid on ties?

Are 7x9-inch oak ties suitable under crossings, or should larger ties be used?

For foundation the best ballast obtainable, preferably stone, not less than 12 inches under the ties, and where good natural drainage is not obtainable, tile should be used.

In general, crossings for heavy traffic should be of large section, not under 75 pounds. They should have wrought-iron or steel fillers, heavy angle bars and Easer rails the entire length, even on very light angles. For 60 to 70 pound steel the bolts should be 1 inch. From 75-pound to 80-pound, 1⅛ inch, and for 90 to 100 pound steel, 1¼ inch.

The best practice seems to be to use plates only at the angles, to support these points properly on the ties and to act as a binder. These plates vary from ⅝ inch to ¾ inch thick.

Where steam tracks cross street railways, or where steam roads of light traffic cross, the Easer rail on the light tracks should be dispensed with, as the crossing would no doubt require replacing for the heavy traffic before it failed for the lighter tracks, and the use of Easer rails on these tracks would be money wasted.

JOINTS AND FASTENINGS.

Bangor & Aroostook Railroad.—Four-hole angle bars, suspended joints. Sternberg bolt. They say of this bolt, which is a grip bolt, with "Ideal" recessed nut, "the most satisfactory we have in use."

Choctaw, Oklahoma & Gulf.—Sixty-five-pound standard, 38-inch 6-hole angle bar, with 21-32 web. Three-fourths-inch bolts, hexagon nuts and nut locks. Seventy-pound standard 38-inch 6-hole angle bar, ⅞-inch bolt with hexagon nuts, nut locks, web 11-16-inch. Supported joints with both sections of rail.

Chicago & North-Western Railway.—Twenty-six-inch 4-hole angle bar with base plates. Seven-eighth-inch bolt, 9-16-inchx5½-inch spike.

Chicago, Rock Island & Pacific Railway.—Twenty-four-inch "Continuous" joint 4-hole, ⅞-inch Harvey grip bolt. Ideal nut, no nut locks. Report very favorably on the "Harvey Grip" bolt.

Denver & Rio Grande Railroad.—Eighty-five-pound steel, 4-hole sus-

pended joint. Weight 52 pounds per pair; 65-pound steel, 6-hole supported joint, weight 68 pounds per pair.

Great Northern Railway.—Thirty-six-inch, 6-hole angle bar, weight 13-16 inch, ¾-inch bolts.

Elgin, Joliet & Eastern.—Thirty-eight-inch, 6-hole angle bar, spike holes through flange instead of notches.

Illinois Central Railroad.—Forty-inch, 6-hole angle bars, ⅞-inch bolts, Verona nut locks.

Intercolonial Railway of Canada.—Forty-two-inch fish plates, with 6¾-inch bolts, 26-inch fish plates with 4⅞-inch bolts.

Kansas City, Fort Scott & Memphis Railway.—Twenty-four-inch angle bar, ¾-inch rolled steel Harvey Grip bolts, no nut locks. "We have used the Harvey Grip Bolts for a long time, probably 10 years. We think we get better results than with V threads and nut locks.

Lake Shore & Michigan Southern Railway.—Twenty-four-inch angle bars, ¾-inch bolts, Harvey Grip.

Michigan Central Railroad.—Ordinary angle bar, long truss joint, Little "Fisher Bridge Joint." Report favorably on the latter two.

Missouri, Kansas & Texas Railway.—Continuous joint.

Nashville, Chattanooga & St. Louis Railway.—Eighty-pound angle bars, 6⅞-inch bolts, spring nut locks, all nuts on *outside*.

New York Central & Hudson River Railroad.—Eighty-pound, 36-inch, 6-hole bar, ¾-inch Grip bolts. Weight of angle bars per pair, 64½ pounds. No nut locks. Tie plates. One hundred-pound, 36-inch, 6-hole angle bar, ¾-inch Grip bolts. Weight pair, 80-pounds, 3-tie joints not less than 5 inches between ties.

Peoria & Pekin Union Railway.—Twenty-eight-inch 6-hole angle bar, drilling 2 inches-5 inches-5 inches, ⅞-inch bolts. Verona "Tail" nut locks.

Philadelphia & Reading Railroad.—Ninety-pound, 28-inch, 6-hole angle bar. Bolted alternate inside and outside joint, ⅞-inch bolt and nut lock. Web ¾-inch, 90-pound 30-inch 6-hole joint angle bar, ⅞-inch bolt and nut lock, web 11-16 inch.

Rock Island & Peoria Railway.—Eighty-pound rail, "Continuous" joint, 4⅞ inch Harvey Grip bolts. Ideal recessed nut. No nut locks. Twenty-four-inch suspended joint, nuts on inside prior to 1901. Alternate inside and out, and spikes through flange of angle bar from 1901.

St. Louis & San Francisco Railroad.—Twenty-four-inch heavy angle bar, ⅞-inch Harvey Grip bolt. "We use Harvey Grip bolt, and it gives satisfaction."

Union Pacific Railroad.—Seventy-pound, 29-inch, 6-hole, ¾-inch bolts, hexagon nuts and nut locks; 80-pound, 29-inch, 6-hole, ⅞-inch bolts, hexagon nuts and nut locks; 90-pound, 29-inch, 6-hole, ⅞-inch bolts, hexagon nuts and nut locks. All 2-tie suspended joint. "We tried the Harvey Grip bolt, but found they gave us no better service than the plain bolt with the nut lock, and cost more money.

Union Pacific Railway.—Seventy-pound steel, 29-inch, 6-hole angle bar, hexagon nuts, ¾-inch bolts, nut locks, 11-16-inch web, 2-tie joint and tie-plates 10 inches between joint ties. Weight 48 pounds per pair; 80-pound, same, except ⅞-inch bolt, ¾-inch web. Weight pair, 55¾ pounds; 100-pound, same, except 13-16-inch web. Weight 65 pounds per pair.

Vandalia Line.—Seventy-pound, angle bars, 6-hole joints, ⅞-inch hexagon nuts, with Verona and National nut locks; spikes, 9-16x5½.

The joint in most general use is the 4 or 6-hole angle bar, running from 24 inches to 40 inches in length and suspended on two or supported on three ties.

The shortest 6-hole angle bar seems to be 28 inches for a suspended joint.

Probably an angle bar should have as heavy a web section as the rail section will permit.

Where the supported joint is used the angle bar should be long enough to allow room for tamping the joint ties, and this should not be less than 5 or 6 inches.

Many roads are using special types of joints, but where they differ from the ordinary angle bar they are a "truss" or "bridge" type of joint, and as such joints cannot be used in connections around switches, crossings or interlocking plants, it might be advisable for some roads not to adopt them, especially as it is doubtful if they are superior, all things considered, to angle bars.

It would seem advisable for any company to use as few different makes of joints or angle bars as possible, otherwise there will be continual trouble from the multiplication of styles of joints and fastenings.

Bolts with the common V thread and nut lock are largely used, but it is a question if this is now the best practice, since so many roads report excellent results from grip bolts, using the recessed nut and no nut locks.

There are several types of grip bolts, but the principle is the same, i. e., a slightly different pitch of thread on bolt and nut, causing the latter to jam tightly on the bolt. The recessed nut seems to prevent battering of the thread, and is indorsed quite generally. In general, these grip bolts are made with rolled thread.

The objection to the grip bolt seems to be the cost, and also the fact that it is a patented affair.

GUARD RAILS.

By Wm. W. Gwathmey, Jr.

A guard rail is a device placed between the track rails for two purposes—first, to prevent derailments of car wheels at frogs and switches and on curves of short radius; second, to control car wheels and prevent their leaving the ties, causing the wreck of cars or bridges.

Guard rails are chiefly used to prevent derailments at turnouts, and are placed, generally, with center of guard rail opposite the frog point. Some engineers prefer to place the guard rail with the center from one to three feet nearer the switch, and to this there is no objection. The guard rail should be not less than ten feet long for yard turnouts, and not less than fifteen feet long for main line turnouts. The guard rail should be the same height as the main track rail. The clearance between gauge lines of guard rail and main rail should be not less than one and three-quarters (1¾″) inches nor more than two (2″) inches. Accurately speaking, the gauge lines of the guard rail opposite the point of frog should be placed not less than four feet six and three-quarter inches (4′ 6¾″) from the gauge line of the frog point.

The flanges of guard rails should be planed off to admit the gauge line of guard rail being placed with proper clearance from main rail, and to allow space for spiking the main rail. Not less than five feet of the middle section of the guard rail and the ends of the straight section should be bent in such manner that the gauge line of the guard rail shall open gradually from the main rail until the clearance between the gauge lines of the guard and main rails shall be not less than four inches, and, preferably, six inches.

Guard rails should be securely fastened to the main rail with not less than two malleable iron clamps fitted with keys and have adjustable wedged-shaped blocks between main rail and guard rail for maintaining the correct guard rail clearance, or bolted through cast-iron filling blocks. They should be securely spiked to the cross-ties, and braced with not less than four rail braces.

We do not recommend placing guard rails in advance of facing split switches except where the turnout leaves the track on a curve, at which point the wheel flanges bear strongly against the outer rail. Guard rails should be used in connection with special grade crossings and slip-switch devices used at yards and terminals to square trucks leaving a sharp turnout and approaching rigid frog points.

We do not recommend guard rails on curves of more than three hundred feet radius. On curves of two hundred feet radius and less guard rails are necessary.

The Committee does not recommend the use of filling blocks for foot-guard protection unless their application is extended to the ends of guard rails, at switches, crossings, frogs, or other points in track where trainmen are subject to similar danger as at the heels of frogs.

We recommend the use of guard rails on through bridges and high-deck bridges, trestles and viaducts. The guard rails should be placed inside the track rails, the gauge lines of the guards being placed seven inches from the gauge lines of the track rails. At the ends approaching the structure the ends of the guard rails should be drawn gradually to a point at the center of the track and securely bolted. The rails at this point should be planed down, so as not to catch hanging brake rods or beams under trains. The guard rails should be securely spiked to the ties after the manner of the main rails. The curved approaches should

be braced on the inside. After considering bridge guards made of iron angles and wooden guards with angle-iron protection, we recommend the use of ordinary railroad rails the same height as the track rails.

Your Committee would be glad to have the experience of members of the Association concerning rerailing devices used in connection with bridge guards.

The above recommendations are respectfully submitted to the Committee for discussion and amendment.

The practice on the roads named below is as follows:

Atlantic, Valdosta & Western Railway.—Guard rail 15 feet long, bent to a crescent shape with 1¾-inch flangeway at point of frog, and 4-inch opening at each end for 4-foot 8½-inch gauge. For 4-foot 9-inch gauge give 2-inch flangeway at frog. Foot-guards are necessary and can be made of wood and placed at heel of frog and switch.

Bangor & Aroostook Railroad.—Flangeway 1¾ inches, except where curvature and widened gauge calls for more. The Hart foot-guard is used.

Buffalo & Susquehanna Railroad.—Spacing for flangeway for guard rails are 1¾ inches, the gauge of track for frogs and switches always being 4 feet 8½ inches. The curves of straight line guard rails are ordinarily kept in place and from overturning by three rail braces, with a few exceptions in yards, where the guards are bolted to the main rail with three ¾-inch bolts, with heavy washers, made of old fish-plates, on the outside, no spacing blocks being used between the main rail and guard rail. No foot-guard protections are used.

Bismarck, Washburn & Great Falls Railway.—Guard rails are 15 feet long, with 2-inch flangeway. Wooden foot-guards are used.

Chicago & Alton Railway.—Guard rails 15 feet long; flangeway 1⅞ inches, plus for gauge widened for curvature. Guards are placed opposite midway between frog point and joint of spring rail. Guards are held in place by spikes and braces, and are bolted through cast-iron filler blocks to the main track rail. Guard rails for rigid frogs are placed centrally, opposite the frog points, and spiked and braced in position. Clearance on bridge guards is 8 inches.

Chicago & Eastern Illinois Railroad.—Length of guard rail 15 feet. clearance 1¾ inches. Spiked to tie and bolted to main rail through filler blocks. Clearance for bridge guard rails is 8 inches.

Cincinnati, Hamilton & Dayton Railroad.—Extract from Book of Rules: "Guard rails must be placed not to exceed 2 inches from the main rail, and in accordance with the standard plans and diagrams."

Chicago, Milwaukee & St. Paul Railway.—Flangeway 1⅞ inches. Hart foot-guard.

Choctaw, Oklahoma & Gulf Railroad.—Flangeway spacing throughout is 2 inches, with guard rails flared at the ends. No foot-guards.

Chattanooga, Rome & Southern Railway.—Flangeway 2⅛ inches.

Delaware, Lackawanna & Western Railroad.—Length of guard rails 15 feet at spring frogs and 7 feet 6 inches at rigid frogs. Guard rails at spring frogs are fastened with 3 cast filler blocks and 4 bolts with braces;

at rigid frogs they are fastened with two bolts through cast filler blocks and braces.

Denver & Rio Grande Railroad.—Flangeway 1¾ inches for main line and 2 inches for yards. No foot-guards used.

Duluth, South Shore & Atlantic Railroad.—15 (15) feet long, bent 12 inches each side of frog point with 2-inch flangeway. "In my experience this is the only guard rail."

Elgin, Joliet & Eastern Railway.—Flangeway 1¾ inches. Cast-iron guard filler and foot-guard.

Georgia Railroad.—Spacing of flangeway 2¼ inches. No foot-guards.

Houston & Texas Central Railway.—Flangeway 2 inches. No foot-guards.

Illinois Central Railroad.—Length of guard rail 15 feet. Flangeway 1⅞ inches, guard rail placed so that when one end of a 4-foot 8½-inch gauge is placed against the frog point, the face of the guard rail will be 1⅞ inches from the other end of the gauge. The guard rail is placed centrally, opposite point of frog. The guard rail is spiked to the ties, and bolted to the main rail through cast iron filler blocks. The guard rail has 6-inch flare at each end.

Foot-guard protection is applied at each end of the guard rail and at each end of frog.

Intercolonial Railway of Canada.—Spacing of flangeway is 1¾ inches. Foot-guards have iron blocks filled with either wood or waste.

Kansas City, Fort Scott & Memphis Railway.—Standard flangeway is 1⅞ inches. Hart foot-guards used in yards.

Louisville & Nashville Railroad.—Extract from Book of Rules: "The gauge side of the frog guard rails must always be placed 4 feet 6¾ inches from the point of frog, regardless of the gauge of track."

"Frogs and guard rails must be blocked or provided with foot-guards in those states where it is required by law."

Michigan Central Railroad.—Length of guard rails 15 feet, placed with center opposite point of frog, spiked and braced. The spacing of flange rail from main line rail with vertical sides to their heads is 2 inches opposite the frog, and for same distance each way beyond this 2-inch space is maintained. In connection with slip switches with rigid center frogs, we put in position a guard rail about 1½ inch from the rail for squaring trucks which have come through a "Y."

In general use, wooden frog and switch blocking is used for foot-guard protection, but in the state of Ohio we are using metal foot-guard protection, as required by law. Jordan Bridge Guard is used.

Missouri, Kansas & Texas Railway.—Flanges of rail at guard rails are placed close together with ends open 6 inches. Wooden foot-guard is used, cut to fit different patterns of rail, which is driven in between webs of rails.

Missouri Pacific Railway.—Spacing of flangeway is 1⅞ inches. Foot-guard protection at frogs always.

Nashville, Chattanooga & St. Louis Railway.—Length of guard rail 15 feet. For 4-foot 9-inch gauge a flangeway of 2 inches is required. Our gauge is gradually being changed to 4 feet 8½ inches, and flangeway for this gauge is 1¾ inches. Guard rails are spiked and braced and placed with 10 feet of guard rail toward switch point, from point opposite frog point. Foot-guards are made of wood. No other safety devices. No guard rails on bridges other than timber guards.

New York Central & Hudson River Railroad.—Guard rail 15 feet long, with flangeway 1¾ inches, opened to 5 inches at ends. Flangeway is increased when gauge of track exceeds standard. Guard rail is spiked and braced, and placed with center 2 feet 3 inches ahead of frog point. All guard rails, frogs and switches are blocked with wooden fillers.

New York, New Haven & Hartford Railroad.—Length for spring frogs 15 feet, for rigid frogs 10 feet. Clearance 1¾ inches. Guard rails are fastened with two clamps and filling blocks. Three feet at each end of rail curved. Guard rails on bridges have 8-inch clearance, and rails are drawn to a point 60 feet from end of bridge.

Pennsylvania Railroad.—Length of guard rails 15 feet, clearance of flangeway 1¾ inches, placed opposite frog point, with center 1 foot ahead of frog point. Guard rail is straight for 3 feet in middle, and the 6 feet on each end is curved to give 4-inch clearance at ends. Guards are spiked and braced, and clamped to main rail with 2 heavy malleable iron clamps and wedges. Guard rails on bridges have clearance of 7 inches, and ends are brought to a point 60 feet from end of bridge.

Peoria & Eastern Railway.—Spacing of flangeway is 1¾ inches. A cant block is used and bolted to both rails by one ⅞-inch by 7-inch bolt, thus insuring the correct clearance at all times. Foot-guard protection is provided by the use of wooden pieces or gravel.

Rock Island & Peoria Railroad.—Length of guard rails for main line is 15 feet. Flangeway is 1⅞ inches, and is maintained by case blocks and ⅞-inch bolts. Deflection of wing is 1 inch in 10 inches. Foot-guard protection is provided by wood for 60 pounds and lighter steel, with cast blocks for 80-pound steel.

Seaboard Air Line Railway.—Length of guard rails 15 feet. Flangeway 1¾ inches. Guard rails are spiked and braced, but not fastened to main rail. Center of guard rail is placed opposite point of frog. Standard bridge guard is to be adopted. We have never seen the necessity, in our experience, for foot-guard protection.

St. Louis & San Francisco Railway.—Spacing of flangeway is 2 inches. Wooden foot-guards are provided.

Union Pacific Railroad.—For guard rails, see blue print of standard. Hart foot-guard protection is used.

Vandalia Line.—Spacing of flangeway is 2 inches with 4-foot 9-inch gauge, and 1¾ inches with 4-foot 8½-inch gauge. Foot-guard protection not generally used. Those in use are wooden blocks, about 18 inches long, fitted under heads of rails and spiked to cross-ties.

Wisconsin Central.—Flangeway should be 1⅞ inches. Cast-iron blocks used at end of guard rail with bolts passing through the guard rail, main rail and block, are used for foot-guard protection.

Philadelphia & Reading Railway.—Guard rails at frogs are 15 feet long, with flangeway of 1⅞ inches. Guard rails are spiked and braced, and placed with center 2 feet 8 inches ahead of frog point. Guard rails are used at facing point split switches, are 9 feet long, with a flangeway of 1⅞ inches. Twelve inches of the rail nearest switch is curved for an opening of 4 inches at extreme end of rail, and at the other end 5 feet of the rail is curved for an opening of 5 inches at end. The end of guard rail is placed 3 inches from switch point, and the rail is spiked and braced. The guard rails are placed on the side of the open switch point. At the end of double track the guard rail is placed on the side of the closed point. At facing point junctions, a guard rail is placed on each side, with a 2-inch flangeway for a 4-foot 8½-inch gauge, and for a wider gauge there must be a corresponding increase of throat.

TOOLS.

By W. B. Poland.

I present herewith Sub-Committee report No. 5 on tools.

(a) Track Lining Tools, Various Kinds.—I submit recommendations in regard to certain tools without attempting to establish standards.

(1) Bars, Claw.—The goose-neck bar is not recommended on account of variation in the curve, which often results in bending spikes in drawing. The straight claw bar with long heel should be used.

(2) Bars, Lining.—Should be of steel, just as light as they can be made, and not bend under track throwing. They should have wood chisel point, 1½ inch square at lower end for 15 inches, and taper to ¾ inch at the top, length 5 feet 6 inches.

(3) Bars, Tamping—Lower edge should be 4 inches by ½ inch, upper end chisel-pointed.

(4) Bender, Rail.—For curving rail and heavy rail bending the roller type of bender should be used. For bending stock rails, etc., a "jim crow" will do.

(5) Boards, Elevation (or Sighting) for Surfacing Track.—Should be 12 to 14 feet long, painted black, with ¾-inch white strip, the top of which is used for sight line. This strip is in two equal parts, which can be raised or lowered on the board independently by pegs and series of holes ¼ inch apart. The board is set level by means of adjustable iron legs. In surfacing around a curve the outer strip is raised the amount of the elevation. Sight is taken from a block at the eye over a block at the jack to the top of these strips. See sketch A.

(6) Board, Dap.—This is a device designed to aid in getting a uniform and level seat for base of rail. See Fig. E. The tie is adzed down until all the edges of the dap board have a uniform bearing. It is of the utmost importance that ties be adzed in this manner in all first-class track work.

(7) Digger, Post Hole.—The scissor type should be used in preference to hollow cylinder or auger.

(8) Drills, Track.—For yard construction and switch work the crank power drill should be used, supplied to foreman from supervisor's headquarters. For regular section work a ratchet drill will be sufficient.

(9) Gauges.—The gauging surfaces should be arcs of circles, the radius of which is gauge of track. This prevents any variation through not setting gauge at right angles.

(10) Jacks, Light.—For regular section work a light ratchet jack should be used, capacity four to five tons, 10-inch raise.

(11) Jacks, Heavy.—For ballast, surfacing or construction gangs a heavy ratchet or friction jack should be used, capacity 10 tons, raise 16 inches.

(12) Levels.—The board should be thoroughly seasoned. Level tube should be adjustable. One end of board should be fitted with a slide bar and set screws for elevation of curves.

(13) Pick, Tamping.—Tamping end should be 3 inches by ⅝ inch.

(14) Shovels, Track.—These shovels should be No. 2 size. They should have iron handle or iron cuff for handle tamping ties, if used on mud-ballast track.

(b) STANDARD EQUIPMENT FOR GANGS.

I have shown equipment of gangs recommended in tabular form. The quantity will necessarily vary according to force employed and general character of road. (See pages 290, 291.)

(c) HAND CARS.—TYPES IN USE.

(1) Light Section Cars.—These should be made strong and durable, even at the expense of lightness. The platform should be 4½ feet by 6 feet. Handles, iron; axles, 1⅝ inch. Great attention should be given to see that the axles are set well apart, near end of sills.

(2) Heavy, Extra Gang.—Platform 5 feet 6 inches by 8 feet. Handles, iron; axles, 2 inches. In this case, as above, it is of the utmost importance that the axles be set as far apart as practicable to avoid the possibility of unequal weight on ends of cars unbalancing it while running. Many serious accidents have occurred from the neglect of this feature in hand-car construction.

(d) PUSH CARS.—TYPES AND USE.

Each section and yard gang should have a push car. Platform, 5½ feet by 7 feet; axles, 2 inches. Axles should be placed as near end of sills as possible, to prevent same from breaking down or sagging.

Rail gangs should be equipped with a rail or "Larry" car. This has rollers at each end for sliding rail on and off. It is very heavily built throughout.

The beds of push cars and rail cars should cover the wheels.

STATEMENT OF TOOL EQUIPMENT RECOMMENDED FOR REGULAR AND EXTRA GANGS.

Description of Tools.	Earth Bal.	Gravel Ballast.		Stone Ballast.		Rail Laying	Remarks.
	Section Gang, 3 Men.	Section Gang, 4 Men.	Extra Surfcg. Gang, 25 Men.	Section Gang, 5 Men.	Extra Surfcg. Gang, 25 Men.	Extra Gang, 30 Men.	
Axes, Chopping	1	1	1	1	1	1	
Adzes	2	1	4	1	4	8	
Bars, Claw	3	4	4	4	4	10	
" Lining	3	4	12	5	12	12	
" Nipping, for holding ties to rail while spiking	..	..	2	..	2	..	Fork which fits over Rail and under Tie.
" Tamping	..	4	25	..	..	..	Tamping Picks recommended to be used in place of Bars.
Bender-Rail, complete	..	..	..	..	..	1	
Blades for Brush Hooks (extra)	2	2	..	2	..	..	
Bits for Track Drill	2	2	..	2	..	..	
Brace, Carpenter	1	1	..	1	..	..	
Bits for Carpenter Brace	3	3	..	3	..	..	
Boards, Elevation for Surfacing Track	1	1	1	1	1	..	
Boards, Dap, for Adzing Ties	1	1	2	1	2	2	
Boxes, Tool, Extra Gangs	..	..	1	..	1	1	
Book, Rules	1	1	1	1	1	1	Increase No. in Snow Country and in Yards.
Brooms, Common	2	2	..	2	..	2	
Brushes, Whitewash	2	2	..	2	..	..	
Buckets, Water	..	..	3	..	3	6	
Cars, Hand, Small	1	1	1	1	1	1	
" " Extra Gang	..	..	1	..	1	1	
" Push	1	1	1	1	1	1	For Lamplighters, Inspectors, etc., under special conditions.
" Velocipede	..	..	..	..	..	..	
" Rail (or "Larry Car")	..	..	..	..	..	1	
Chains, Locking Cars	1	1	2	1	2	2	
Chisels, Track	3	3	3	3	3	12	
Cans, Oiler, Handcar	1	1	2	1	2	2	
" 2 Gal	1	1	1	1	1	1	
" 5 "	1	1	..	1	..	..	
Cups, Tin	1	1	2	1	2	2	
Drills, Stone	2	2	..	2	..	..	Rock Country only.
Diggers, Post Hole	1	1	..	1	..	..	
Dippers, Tin	..	..	2	..	2	2	
Files, Large Flat	2	2	1	2	1	1	
" Hand Saw	1	1	..	1	..	..	
Forks, Rail (rail gang)	..	..	..	..	..	2	
" Ballast (rock ballast)	..	..	..	4	15	2	
Flag Covers, Tin	1	1	1	1	1	1	
Flags, White	2	2	2	2	2	2	Where used as Signals.
" Red	4	4	4	4	4	4	
" Green	4	4	4	4	4	4	
Gauges, Track	1	1	3	1	3	3	
Grindstones, complete	1	1	..	1	..	..	
Globes, Lantern, White (extra)	1	1	1	1	1	1	
" " Red "	1	1	1	1	1	1	
" " Green "	1	1	1	1	1	1	
Hatchets	2	2	..	2	..	..	
Hooks, Brush, complete	2	2	..	2	..	..	
" Tie	..	..	4	..	4	..	Rock Ballast or Rock Country only.
Hammers, Stone	..	..	..	2	2	..	
Handles, Extra for Axe	1	1	1	1	1	1	
" " " Adze	1	1	3	1	3	3	
" " " Pick	2	2	4	2	4	4	
" " " Sledge	1	1	3	1	3	3	
" " " Stone Ham'rs	..	..	..	1	2	..	Rock Country only.
" " " Spike Maul	2	2	4	2	4	6	

STATEMENT OF TOOL EQUIPMENT RECOMMENDED FOR REGULAR AND EXTRA GANGS—CONTINUED.

DESCRIPTION OF TOOLS.	EARTH BAL.	GRAVEL BALLAST.		STONE BALLAST.		RAIL LAYING	REMARKS.
	Section Gang, 3 Men.	Section Gang, 4 Men.	Extra Surfcg. Gang, 25 Men.	Section Gang, 5 Men.	Extra Surfcg. Gang, 25 Men.	Extra Gang, 30 Men.	
Jacks, Track, Light, 5 tons	1	1	2	1	2	..	
" " Heavy, 10 tons	..	..	2	..	2	..	
Kegs, Water	1	1	2	1	2	2	
Lanterns, White, complete	2	2	2	2	2	2	
" Red	2	2	2	2	2	2	
" Green	2	2	2	2	2	2	
Levels, Track	1	1	1	1	1	1	
Mauls, Spike	2	2	6	3	6	8	
Mattocks, Grubbing	1	1	..	1	..	..	
Picks, Clay	2	2	10	3	..	3	
" Tamping	..	2	10	5	25	4	Recommended, but Bars can be substituted.
Platforms, Dumping for Push Cars	1	1	1	1	1	..	
Pliers, Wire	1	1	..	1	..	..	
Punches, Rail	1	1	1	1	1	3	
Rakes	1	1	..	1	..	..	
Ratchet for Track Drills (extra)	1	1	..	1	..	1	
Saws, Hand	1	1	1	1	1	1	
" Crosscut	1	1	1	1	1	1	
Scythes, complete, Briars, Brush and Grass	3	4	..	5	..	..	
Scythes, Blades for Grass (extra	1	2	..	2	..	..	
" " " Briars "	1	1	..	1	..	..	
" " " Brush "	1	1	..	1	..	..	
Shovels, No. 2 Track	3	4	25	5	20	6	Fitted with iron cuff for mud ballast.
" Scoop	..	..	..	..	..	..	As may be needed in snow latitudes, or where coal is handled.
Stretchers, Wire Fence	1	1	..	1	..	..	
Sledges, weight 12 lbs	1	1	4	1	4	4	
Tape Lines	1	1	1	1	1	1	
Templet, Standard Roadbed	1	1	1	1	1	..	
Tongs, Rails	..	..	..	..	..	8	
Torpedoes	12	12	12	12	12	12	
Wheelbarrows, Iron	1	1	..	1	..	..	Or Barrows to run on rail.
Wrenches, Track	3	3	2	4	2	10	
" Monkey	1	1	1	1	1	1	
Whetstones	3	3	..	4	..	..	

SUPPLIES CARRIED AT HEADQUARTERS.

(SUPERVISORS' OR ROADMASTERS'.)

To be sent out as needed and returned when work is completed.

DESCRIPTION OF TOOLS.	NUMBER.	REMARKS.
Bender, Rail, Roller Type, complete	1	
Block and Falls, 1½ in., with Lines	1	
Car, Light Inspection	1	
Drills, Rail, Power	1	
Lights, Wells' or Buckeye Type	1	For Wrecking.
" Flares (Coal Oil or Gasoline)	6	For Wrecking.
" Torches	24	For Wrecking.
Mower, Lawn	1	
Plow, Ditching, Heavy	1	
Shovels, Long-handled	12	
" Scoop	12	
Spades, Ditching	12	
Saw Rail, Power	1	
Wheelbarrows, Track	12	Fitted to run on rail.

Supervisors will also hold at headquarters a small number of emergency tools and extra parts. This supply should be as small as experience on each road shows to be safe.

(e) DUMP CARS.

Each section, ballast or dressing-up gang should be equipped with a dumping device to be applied to push cars, which will dump on either side of car and dump quick. The platform shown in Fig. B is recommended. This can be set on any push car, is easily removed and put out of the way when not wanted, and can be dumped in an instant by one man, thus avoiding the danger of working on the main track with a permanent dump car.

For yard gangs permanent dump beds should be furnished for dump cars. These may be side dumps, Fig C, or Fig. D, if cinder pit can be reached.

(f) METHOD USED IN SUPPLYING AND CHECKING USE OF.

(a) In ordering material the foreman should make requisition on the supervisor. In ordering new tools, the foreman should be required to return the old tools.

(b) The supervisor should make requisition on the division engineer, or other superior officer, or storekeeper.

(c) Material is sent out directed to supervisor or foreman. A manifest is sent to the supervisor, on which the material is charged against him.

(d) Supervisor should keep book account with each section and charge foreman with all material sent him during month, also should keep account of material released.

(e) Section foreman should make monthly tool report to supervisor, which must check with supervisor's book account.

This report is made on sheet divided into columns as follows:

(1) Description of tools.
(2) Tools on hand first of month.
(3) Number disposed of.
(4) How disposed of.
(5) On hand last of month.

An inventory of all tools is to be taken once every six months. The foreman's report "on hand last of month" must check with this.

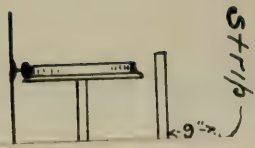
GENERAL QUESTIONS.

By H. F. Baldwin.

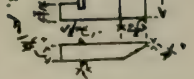
As outlined in the list of subjects assigned to this Committee, the four subdivisions of this heading may well be reduced to one, "*Cleanliness.*"

In the desire to get all the work possible done with the usually small track forces, the importance of cleanliness as applied to track is too often overlooked. In a few minutes at the end of each day's work, a gang can clean up all the material left after the day's work: in a few minutes daily the station agent or his helper (except in very large towns or terminals) can clean up the station grounds and dispose of all refuse and waste; and

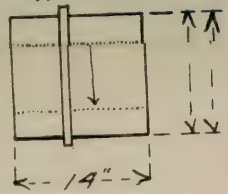
PUSH DUMPED IN ASH PITS.

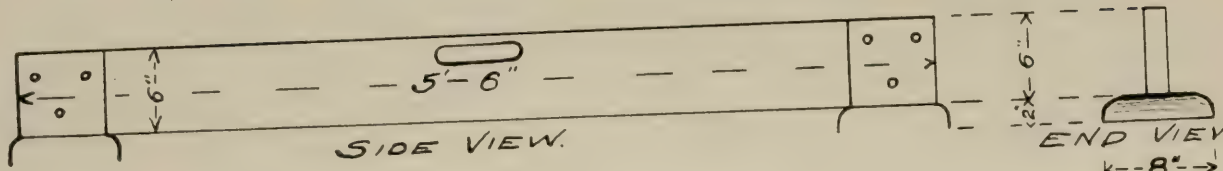


STRIP



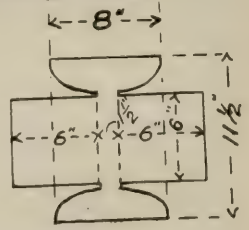
LIGHTING BL





SIDE VIEW.

END VIEW.



DEVELOPED SURFACE.

DAP BOARD

MADE OF #16 SHEET STEEL & 1½" PINE.

FIG. E.

A. R. E. & M. of W. Assn—Track.

—TO ACCOMPANY TOOL REPORT.—

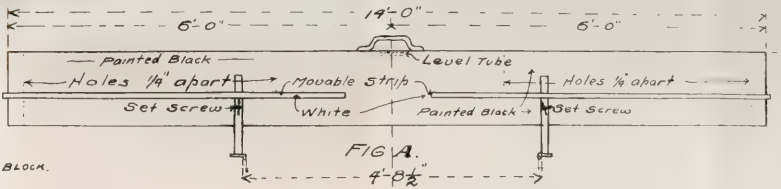
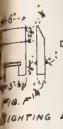


FIG. A.



SIGHTING BLOCK.

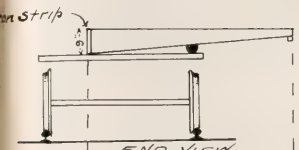
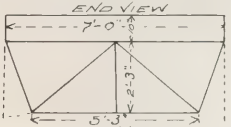


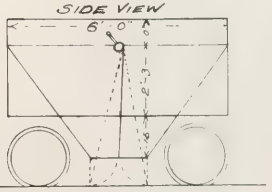
FIG. B



—FIG. C—

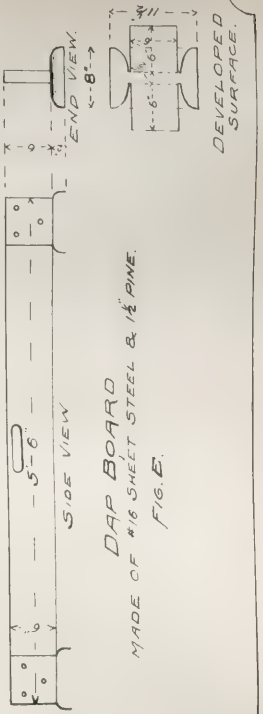
PUSH CAR — DUMP BED.
(REMOVABLE)
—— FOR YARD GANGS ——
ETC.

PUSH CAR — DUMP PLATFORM



—FIG D—

HOPPER BOTTOM DUMP CAR
FOR YARD GANGS WHEN CAR CAN BE DUMPED IN ASH PITS



DAP BOARD
MADE OF #16 SHEET STEEL & 1/2" PINE.
FIG. E.

with proper encouragement from superiors, foremen and agents soon learn to take great pleasure in maintaining clean and neat tracks, station grounds and stations.

Most railroads have to economize, so that while all officers would like to have their tracks clean, on some roads all the money available has to be expended in necessities; but even the poorest can have clean tracks and clean station grounds, though on poorer lines track with grass, or even weeds growing in it must, of necessity, be considered clean.

There often is a legitimate excuse for allowing grass and weeds to grow in tracks, and adjacent to them, but there can be none for allowing scrap, old ties and other rubbish to be scattered about.

Trackmen should clean up after each day's work; once a week each foreman should go over his entire section, pick up all scattered material and carry it to its proper place. Scrap bins should be provided at each tool house. Once a month all scrap, including car material, etc., from each section should be loaded into cars and shipped to the proper headquarters, usually to where the larger shops are located.

Grass and weeds should be cleaned out of tracks and ditches and to the top lines of embankment at least once a year, where, because of the character of the ballast, the growth of grass and weeds is unusually rapid. This should be done twice each season, preferably in this climate in June and October.

Once a year the weeds and high grass should be mowed within the right-of-way limits, and burned as soon thereafter as they are dry enough. This should always be done while they are green and before the seeds of weeds have ripened. The time for mowing varies with the climate—from June in some sections of the country to early in September in others. In some localities, where the growth of weeds is very rapid, this mowing is necessary twice each season. Where weeds and grass are killed by frost, and where snow does not prevent it, the right-of-way should be burned over in winter.

Boxes, baskets or cans should be furnished at each station to be used as receptacles for scrap paper, etc. The patrons appreciate them, and many, who otherwise would throw paper on floors or platforms of the stations, or onto the tracks, soon learn to use these receptacles.

Whatever cleaning of station grounds cannot be done by the station agent, or his helper, should be done by trackmen. Where track walkers are employed they should be required to keep station grounds clean, at places where the agent cannot do the work, and at such places if trackwalkers are not employed, the track foremen should clean the station grounds thoroughly at least twice a week; but agents should understand always that they alone are responsible for the cleanliness of stations and station grounds.

Painting should be done often enough to keep the buildings looking clean and well preserved. Buildings and signboards generally should be painted once in three years; where light colors are used—especially on lines of heavy traffic which use soft coal—perhaps twice as often.

Semaphores, switch targets, etc., should be painted once a year under favorable conditions, and twice a year under unfavorable conditions.

Wing fences at cattle-guards, fences around section houses, etc., and stock-pen fences should be whitewashed once each season, preferably in summer, and before the fall rains.

H. F. BALDWIN, *Chairman*, Chicago & Alton Ry., Chicago;
W. M. CAMP, *Vice-Chairman*, Railway Review, Chicago;
H. C. LANDON, Buffalo & Susquehanna Ry., Austin, Pa.;
C. L. ADDISON, Long Island Railroad, Hempstead, N. Y.;
S. B. FISHER, M., K. & T. Ry., St. Louis, Mo.;
N. NEFF, Pennsylvania Lines, Columbus, O.;
W. H. KIMBALL, Rock Island & Peoria Ry., Rock Island, Ill.;
W. B. POLAND, B. & O. S. W. R. R., Washington, Ind.;
W. W. GWATHMEY, JR., Seaboard Air Line, Portsmouth, Va.;
G. S. CHEYNEY, N. Y. C. & H. R. R. R., Buffalo, N. Y.;

Committee.

Mr. H. F. Baldwin (Chicago & Alton):—We have here as our report some articles written by the different members of the Committee on Track, which we submit to the Association, with the request that we be criticised as severely as we ought to be, and with the hope that next year we may be able to submit a report of the Committee.

Mr. W. S. Kinnear (Michigan Central):—As I understand it, this report simply gives the opinions of the individual members of the Committee, and they make no recommendation for adoption by the Association.

Mr. Baldwin:—That is right.

Mr. V. K. Hendricks (Terre Haute & Logansport):—It is important, for economy, to avoid readjusing the elevation of curves as much as possible, and in order to accomplish this object the Association should adopt elevations which will take into consideration the variable factors which govern the proper elevation. These variable factors are the speed for which the elevation should be established and the degree of the curve. With double track on a heavy grade the elevation of the curves for fast passenger traffic is often made different on the two tracks, and it is proper that it should be so. It is not, therefore, proper that we should adopt recommendations which provide for placing the same elevation in the two tracks to start with, when we know to start with that one of them must be changed to give satisfactory results. The use of good judgment as to the proper

speed to assume, together with tables for the elevations for different speeds and degrees of curve, will make it possible to very largely reduce the cost of readjusting the elevations. The proper elevation can be determined in the office before the work is done, so that tables are not objectionable. I presume in such cases as mentioned the Committee would not recommend a strict adherence to the rule, but if that is the case the value of the rule is diminished, and rules should be adopted which can be strictly adhered to when the judgment as to the proper speed to assume is correct.

Mr. Churchill (Norfolk & Western) :—I heartily agree with the last speaker. I think the simple method of arranging track elevation is to issue tables of the proper elevations for different speeds. At a station where all trains stop you certainly don't want much elevation, and you don't want much elevation on a sidetrack. If you issue standard tables for proper elevation according to speed, it is applicable to any part of a railroad.

Mr. W. M. Camp (Editor Railway and Engineering Review) :—It has been said that these sub-committee reports represent the personal opinions of the sub-committees. It is stated in this report of curve elevation that such is not the case exactly. Though my views concur very nearly with the report, they do not exactly. The recommendations of the report are made up as nearly as the Committee could form them from the information that was sent in.

Now in reference to the remark in regard to the speed of trains, it seems to me that when you assume a speed which is a compromise of the different speeds of traffic—freight and passenger—there is no need of using the formula, because you are departing from what is supposed to be the realm of its application. Taking Searles' formula, which is the general formula, and using a speed of 60 miles per hour, you would have to elevate four-degree curves about 10 inches, which is not practicable, and the elevation of a three-degree curve would be 7½ inches. That is above the maximum limit of elevation of most roads. The great majority of the roads fix their maximum elevation at 6 inches. Now you see that formula applies no further than a three-degree curve. Beyond that it is customary to assume a speed of 40 miles per hour and work out the curve

elevation for that speed. But you know you have higher speed than that if you are running passenger trains, and so, it seems to me, that after all it comes right back to elevating the curves by trial. There is a semblance of adhering to scientific principles by using a formula; but in practice we know that the general formula is not applied strictly at all, except to curves of small degree; and so that paragraph—paragraph 2—referring to that point, reads: "Adopting the method of trial any *formal* consideration of the speed of trains is immaterial."

For mixed traffic, an elevation of one inch per degree is safe; and if you have to adjust your elevation for faster speed than that elevation will answer for, you are not going to depart from that very far. If you adjust it for a lower speed, you are not liable to get below three-quarters of an inch. So you are within the ordinary rules of thumb. In fact, the information furnished this Committee as to the practice of the sixty roads that are represented by the seventy-four replies, proves the assertion that the curve elevation is tentatively a matter of rule of thumb, and these rules that are submitted here are intended to be only approximate. Still, we know that they are safe.

On a road handling mixed traffic, where the freight traffic is at all important, it is not expected that on the sharp curves the elevation can be sufficient for the smoothest riding of the passenger trains; but a rule quite widely followed is to so elevate the curves that the passenger car bodies will not tilt beyond the level at the highest speed. If you will look at the replies touching the question of damage to track from excessive elevation by the heavy freight trains, you will see that there is a general tendency on almost all roads to compromise the elevation as between the requirements of the freight and passenger traffic. When you profess to use the general formula and then assume a speed which is less than that of the usual passenger traffic, it is, in the estimation of the Committee, done for the appearance of trying to follow a mathematical rule. Almost all of the gentlemen replying to the circular who stated that they were using a set rule for curve elevation, explained that they followed the rule but loosely and adjusted the elevation to suit the conditions of traffic.

Mr. W. McNab (Grand Trunk):—I ask the Chairman of the Committee whether, in the replies he received, notice has been taken of the fact, in the case of double tracks, that each track must be treated as an individual line in regard to elevation of curves where the speed is different.

Mr. Baldwin:—Quite a number of roads, in replying, did call attention to that fact. If they had a double-track line on a heavy grade, the elevation on the down track is greater than on the up track, and I think that is the general practice, judging from the answers we received.

Mr. P. Alex. Peterson (Canadian Pacific):—I have paid close attention to the question of joints. It seems to me that the question of joints is one of the most important matters we have in connection with track. In the American Society for a good many years we have been endeavoring to get a committee on joints, but so far we have not been successful; but I hope this Association will take the matter up in a very thorough manner, because I think anyone can see by walking along a track and by watching trains passing over joints, that in our tracks the joints of the rails are the weak point. You will find that the rails are hammered at the joint. You will find that in wet seasons the water will fly up from under the joints, while the track seems to be in fair order between the joints. I would like to hear from the Committee whether they have given this matter consideration, or whether they thought it a matter not worth considering.

Mr. Baldwin:—We thoroughly appreciate the importance of the subject of joints, and hope to make a report that will bring out all the good points of joints and all the bad points of the ones we are ordinarily using.

The President:—We realize that this Committee, as well as our other committees, cannot solve all our difficulties in one year.

Mr. Peterson:—The Committee says, among other things, the following: "Many roads are using special types of joints, but where they differ from the ordinary angle-bar they are a 'truss' or 'bridge' type of joint, and as such joints cannot be used in connections around switches, crossings or interlocking plants, it might not be advisable for some roads to adopt

them, especially if it is doubtful if they are superior, all things considered, to angle-bars. It would seem advisable for any company to use as few different makes of joints or angle-bars as possible, otherwise there will be continual trouble from the multiplication of styles of joints and fastenings." We do not want to use a multiplicity of joints. We want to get the best one and all use it, and we want to get from this Committee an opinion of which is the best one. We want to be able to refer to this Committee as an authority on the subject. If they say that a certain form of joint should be adopted we want to adopt it.

Mr. A. W. Sullivan (Illinois Central):—I have not much to say as to the subject matter of the report, because in the first place it is worthy of a great deal more study than I have had time to give it, or, for that matter, any of the other members of the Association, as it has not been in their hands long enough to receive proper consideration. But I want to say something of the report itself, because it is an illustration of a feature of committee work that I think the Association should have some definite ideas about. This report is not a report of a committee. It contains none of the elements of a committee report. In the first place, it is too long; it refers to too many things. The individual papers which have been prepared on the different subjects are handled with much skill and undoubtedly express the judgment of the writers, but that is not what the Association wants. It is not what the railroads of the country need. The development of the service has now reached a point where the opinion of no one man is of sufficient value to be a guide to the profession. For that reason associations are necessary, and the work of associations must be done by and through committees. The functions of a committee is to investigate collectively each subject assigned to them, present to the Association such phase of the subject as in the judgment of the committee is needful for the hour, and to lay before the Association all the information it can gather on the particular part of the subject which it has investigated, and then, above all things, to submit to the Association its conclusions and its recommendations for action by the Association, to determine whether or not those views shall prevail as being the best practice for the railroads of the country.

There is more to these meetings than merely to come here and listen to interesting papers. The Association has a duty to perform. A committee performs its duty when it lays before the Association a carefully prepared, well studied report, with definite conclusions. The responsibility is then upon the Association to determine whether or not these conclusions are sufficiently well founded to warrant approval. Every report, to be a useful report, should have its conclusions expressed in such terse form and in such concise manner that they can be made the subject of intense discussion—not general and rambling discussion, but an intense consideration of the subject which will conclude with definite action, so that at each meeting successive steps are taken to build up what shall be the standard practice of the profession in this country. These are the elements which are lacking in this report, and for that reason, while the report is extremely interesting, it does not meet the requirements of association work, and the energy and exuberance with which it overflows, as can be readily seen here, is virtually lost.

The members of the Committee, no doubt, have gone to a great deal of trouble and labor in the preparation of the report, and have inflicted much trouble and labor on the members of the Association in answering their questions. The replies as to the inquiries of the Committee have come very generously, and the responses have been satisfactory, as a whole, far above the average. That will last just once. It will not be so exuberant the next time; and if the practice continues of individual members of committees sending out for information, it will be only a short time when the answering of such inquiries will become a great burden and they will get no replies at all. The function of the individual is nothing in a committee report, and it should not be allowed to become important, as all matters should be confined to the committee, and when the committee comes before the Association, it should be as a committee, and the views expressed should be the collective judgment of the committee. If that judgment meets the approval of the broader wisdom of the Association, then principles of practice may be established; and I think that course should prevail, not only in the work of this Committee, but in the work of all the committees of the Association, in order to develop the best results. [Applause.]

The President:—In order that Mr. Sullivan's words may not have the edge taken off by any discussion, we will excuse the Committee.

Mr. Duncan MacPherson (Canadian Pacific, by letter):—The Committee state that "it would seem advisable for any company to use as few different makes of joints as possible," and it does not appear likely that anyone will dispute such an obvious conclusion; but when they claim that it is inadvisable to adopt any other joint than ordinary angle-bars because they state bridge and truss joints cannot be used in connections around switches and crossings, I think the bare statement calls for some proof. Angle-bars themselves require a good deal of cutting and changing to suit switch connections, and it appears to me that most of the other points can be modified in the same way to suit such connections. It is by no means certain that the angle-bar or any other joint which depends upon the absolute and continuous tightness of its bolts, is really a satisfactory joint. It appears to me that it is absolutely necessary to have some bridge or base support at ends of rail which is not dependent upon bolts, which support should cause the ends of rails to work in unison and prevent the initial damage to the rails which, once started, continually gets worse.

Mr. V. K. Hendricks (Terre Haute & Logansport, by letter):—If the center of gravity of a train is assumed to be 6 feet above the rail, it will be found that where a curve has 6 inches of elevation the center of gravity is lowered about ½ inch if the center line of the track were placed at grade, and that the center of gravity would be raised about 2½ inches if the inside rail were placed at grade. This latter would be equivalent to changing the grade of the track 2½ inches in the length of the spiral, and where a curve is located on a ruling grade such a change may be objectionable. In such cases, or where grade stakes are to be set by the engineer corps, I should favor setting the center line of the track at grade, as the result will be nearer what is desired. Ordinarily, I think, this is a minor point, but in adopting standards I think the Association should select the best, and live up to them so far as practicable or economical. I should not recommend lowering track already laid, but merely making the adjustment, where desired, at such

time as a sufficient raise may be given the track to do so. Such elevation can be as well and cheaply maintained in surface and line as when the inner rail is placed at grade.

Mr. F. A. Bryan (Michigan Central, by letter):—It has been my lot on the Michigan Central to have considerable to do with the easing and elevating of curves. Our practice has been to ease all our curves, whatever their degree. While the easement applied to a 30-minute curve may in itself be of no benefit, we find that the re-centering of these light curves, which have been thrown and re-thrown by section men for years, make a decided improvement in their riding, and when so doing it requires but little more labor to apply the easement. Our records are then kept in a uniform manner and each roadmaster and section foreman is supplied with information of curves in his division in the following form:

MIDDLE DIVISION.

Curve No. 10. Section No. 31. Curve to left. East end of curve is 117.8 feet east of post 118½ miles from Detroit and is opposite a stake marked "P. C." West end of curve is 86.0 feet west of post 119 miles from Detroit and is opposite a stake marked "E. C."

Distance west of P. C. at which changes in elevation are to be made.	Elevation to give outer rail.	FROM EAST END OF CURVE THERE ARE	Distance east of E. C. at which changes in elevation are to be made.	Elevation to give outer rail.
Feet.	Inch		Feet	Inch
0	¼	1st. 350.0 ft. easement. Stakes 25 ft. apart.	0	¼
25	½	2d. 206.75 ft. 2°-30'.56 Intermediate curve. Stakes 50 ft. apart.	25	½
50	¾		50	¾
75	1	3rd. 1800.00 ft. 2°-32'.8 Central curve. Stakes 50 ft. apart.	75	1
100	1¼		100	1¼
125	1½	4th. 176.33 ft. 2°-33.12 Intermediate curve. Stakes 50 feet apart.	125	1½
150	1¾		150	1¾
175	2	5th. 350.00 ft. easement. Stakes 25 feet apart.	175	2
200	2¼		200	2¼
225	2½	2883.08 ft. total length.	225	2½
250	2¾		250	2¾
275	3		275	3
300	3¼		300	3¼
325	3½	Elevation to give outer rail between points marked (*) is 3¾ in.	325	3½
No. 350	3¾		No. 350	3¾

Our rates of super-elevation per degree practically agree with those recommended by the Committee, but it is absolutely impossible to obtain the best results by adhering to any fixed rule; the speed and traffic on the curve should always be considered. The method of easing we have used is what is known as a multiple compound curve, as developed by Mr. Torrey some years ago. The degree of the arcs of the curves varies by 10,

15, 20 and 30 minutes. Theoretically this curve is not as correct as the transition spiral, which is one whose degree of curve increases directly as the distance along the curve from the point of curve. In practice, however, there is little difference. A comparison of the two curves may be seen from the following table of offsets for an easement to a two-degree curve which is 275 feet long, consisting of eleven twenty-five-foot arcs of 10 minutes' variation by the Torrey method, and an equal length for the transition spiral.

Length of cord 25 ft.

End of Chord Number.	Offset for Torrey Method.	Offset for Talbot Method.	Difference.
1	.0090	.0033	.0057
2	.0454	.0265	.0189
3	.1272	.0891	.0481
4	.2727	.2116	.0611
5	.5000	.4144	.0856
6	.8270	.7143	.1027
7	1.2726	1.1343	.1383
8	1.8543	1.6931	.1612
9	2.5905	2.4108	.1797
10	3.4993	3.3070	.1923
11	4 5988	4.4016	.1972

It is thus apparent that it practically makes little difference so far as the alignment is concerned whether the easement be a multiple compound curve or a spiral. It is more a question of application. An objection I have found with the Holbrook, Searles and Torrey systems is that in order to lay out a satisfactory easement it is always necessary to have a proper table, and that table may not exist.

Let us assume that a two-degree curve be eased by the Torrey system and that the desirable superelevation at the end of easement be 3 inches, and that the 25-foot arcs vary in degree by 15 minutes. The elevation at the various stakes will then be as follows:

Distance from P. C.....	0	25	50	75	100	125	150	175
Correct Elevation.....	0	0.43″	0.″86	1.″29	1.″72	2.″15	2.″58	3.″00
Actual Elevation.....	0	¼″	¾″	1″	1½″	2″	2½″	3″

It is impossible for track men to work nearer than one-quarter of an inch, and consequently our elevations would have to be recorded as on the third line, and these elevations do not increase at a uniform rate.

This fault is found with all of the above mentioned systems.

It is not serious on short easements where it is desired only to know the elevation at beginning and end, but on long ones I think it desirable to give the elevation at intermediate stakes.

Another objection to the spiral is the mathematics, such as given under head of the Holbrook spiral by the Committee. The average railroad engineer is not a mathematician. He wants something that can be easily understood and readily calculated and applied.

For these reasons I do not agree with the Committee in recommending the Holbrook spiral.

Of the various systems that have been developed, I believe that Talbot's transition spiral, in addition to being theoretically correct, is more simple, more general, less dependent upon a table and more readily meets all conditions than any other. By use of his formulæ a spiral increasing at *any* rate (a) may be located at *any* point, either by offsets or deflections. Without going into the derivation of the formulæ I would like to quote a few of the more general ones, to show their simplicity. Let

L = Number of 100 foot stations from the P. S.
A = Rate of change of degree of curve.
D = Degree of curve at any point on spiral.
Δ = Angle showing change of direction at any given point.
θ = Deflection angle from P. S.
O = Offset between initial and parallel tangent.
Y = Ordinate from tangent.
L = Total length of Spiral.

Then

$$\Delta = \tfrac{1}{2}\, a\, L^2 = \tfrac{1}{2}\, DL = \tfrac{1}{2}\, \frac{D^2}{a}$$
$$Y = .291\, a\, L^3$$
$$\theta = \tfrac{1}{3}\, \Delta = \tfrac{1}{6}\, aL^2 = \tfrac{1}{6} DL$$
$$O = .072\, aL^3$$

It will be seen that he makes *a* the variable in all his formulæ, which is evidently correct, and when this or its equivalent, the rate of increase in the superelevation, is decided upon, the remainder of the work is merely a substitution into simple formulæ. The system entirely overcomes the difficulty I have heretofore referred to in tabulating the elevations for section men, so that the rate of increase of superelevation shall be uniform.

Our experience has been that *a*, for high curve speeds, should be two-thirds, which at 1½ inches elevation per degree would be equivalent to a rate of increase of 1 inch per 100 feet. For

various reasons it is sometimes impossible to make the rate less than 1 inch per 50 feet, but the difference in the riding for the two rates is very susceptible. With a rate of increase of 1 inch per 100 feet it is almost impossible to detect the entering or leaving of a three-degree curve.

In addition to the riding, there is another point apparently in favor of properly eased curves which has not been touched upon by the committee; that is, the ability of freight engines to haul an increased load. While theoretically I see no reason why such should be the case, and am not in a position to state how much, if any, or why the curve resistance is decreased, yet all of our enginemen claim that after a curve has been eased it is decidedly easier to pull heavy loads around them. It is quite probable that this is more the result of relining the entire curve than the easing of it.

Mr. C. S. Churchill (Norfolk & Western, by letter):—In the verbal discussion before the Association on the subject of track elevation, I made a statement that the simplest method for arranging the track elevation is to issue tables giving the proper elevations for the customary speeds maintained on different divisions of a railroad. To make this statement clear, I give below the table used by the Norfolk & Western Railway, which covers both track elevation and the gauge of track on curves.

In explanation, I would state that the form of formula we use for quick calculation of the theoretical elevation, and which was used in the preparation of this table, is as follows (the formula being the usual rule with terms inserted that make it simple and quick of application):

in which

$$E = \frac{V^2 d}{1500}$$

E = elevation of outer rail in inches;
V = speed in miles per hour;
d = degree of curvature.

Referring to table: Elevations for a speed of 25 miles per hour are used on portions of the road where freight traffic is heavy and on branches where curvature is sharp. In case the curvature on such branches is over 12 degrees, the speed is reduced below 25 miles per hour.

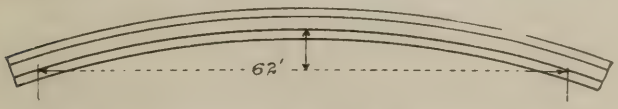
Our maximum elevation is 7 inches, and it is customary to run trains on strongly constructed and well-maintained track, both on this and other roads, at speeds from 50 to 55 miles per hour on curves of 6 degrees having an elevation of 7 inches.

In practice we find that it is not so much the exact half-inch of elevation adopted as standard as it is the maintenance of a perfectly uniform elevation around a curve according to the standard adopted, that is necessary in order to procure a safe and good riding track.

SPEED IN MILES PER HOUR WITH PROPER ELEVATION IN INCHES.

Degree of Curve.	Elevation for speed of 25 miles (Max. 30).	Elevation for speed of 30 miles (Max. 35).	Elevation for speed of 40 miles (Max. 45).	Elevation for speed of 50 miles (Max. 55).	Gauge of Track.
1	½"	¾"	1 "	1½"	4' 8½"
2	1	1½	2	3	4' 8½"
3	1½	2¼	3	4	4' 8½"
4	2	3	4	5	4' 8½"
5	2½	3¾	4¾	6	4' 8½"
6	3	4½	5½	7	4' 8¾"
7	3½	5¼	6¼	7	4' 8¾"
8	4	6	7		4' 8¾"
9	4½	6¾	7		4' 9 "
10	5	7			4' 9 "
11	5	7			4' 9 "
12	5	7			4' 9 "
13	5				4' 9¼"
14	5				4' 9¼"
15	5				4' 9¼"
16	5				4' 9¼"
17	5				4' 9⅜"
18	5				4' 9⅜"
19	5				4' 9½"

To find degree of any curve, mark two points on the rail 62 feet apart, and stretch a line between these points, touching the side of the rail, thus:



The distance from the line at the middle to the side of the rail will be one inch on a one-degree curve, two inches on a two-degree curve, and so on.

Curves to have full elevation at P. C.'s elevation to run out on tangent at the rate of one inch in 50 feet, except in case of short tangents, where rate of change is to be made to suit the length of tangent.

The grade line should be maintained along the inner rail, and the elevation obtained by raising the outer rail.

Where a permanent structure establishes elevation of the outer rail, the same shall be maintained on curved track adjoining.

REPORT OF COMMITTEE ON SIGNALING AND INTERLOCKING

To the American Railway Engineering and Maintenance-of-Way Association:

Your Committee has not completed the work on any of the subjects assigned. Most of the data furnished by the railroads represented in the Association and by the signal companies, which data is being used as a basis for the work of the Committee, was not received until several months after the last annual meeting.

The many changes in the Committee's membership, only one of the original members now being on the Committee, and the consequent inability to hold meetings, prevented any effective work being done until this winter.

Meetings were held January 22d and February 12th, which were attended by four and five members, respectively. It is to be regretted that more has not been accomplished, but enough has been done to show that the Committee has not been idle since the January meeting and to indicate the character of the work to be performed.

As stated in the preliminary report made at the last annual meeting, the subjects which the Committee would consider first would be those relating to interlocking plants. The joint use and ownership of so many plants by two or more railroads makes the general adoption of like rules, specifications and standards relating to such plants a matter of considerable importance.

It may be readily seen that these subjects, therefore, are of greater moment than those which pertain to the signaling of each road individually, and consequently should take precedence over those signal matters which affect each road separately.

Considerable work has been done on plans and specifications.

Blue prints of the plans completed are submitted herewith.

As numerous references to the plans will be made in the specifications, the latter will not be ready for submission until all of the plans are completed.

The usual practice of committees is to complete first the general definitions covering the subjects under consideration, but this Committee thought it would accomplish most by the method it is pursuing. It is expected, however, that the definitions and the rules on maintenance will be ready for submission with the plans and specifications.

The Committee will give careful consideration to the definitions and rules relating to signaling which have been promulgated by other

railroad associations, and whenever possible such definitions and rules will be recommended for adoption.

The Committee has endeavored to go rather minutely into the specifications governing the installation of interlocking plants and into the detail designs of interlocking appliances.

The many years of development in this branch of signaling has inevitably led to the establishment of certain fixed principles and certain fixed types of apparatus.

The lack of organized efforts on the part of the railroad companies has, however, prevented that uniformity in designs and methods which is necessary to secure the best results.

The materials at hand are sufficient and of such a character that this uniformity may be secured by following the best practices now in vogue.

The adoption of standard designs of signal, switch and lead-out material by most of the railroads will materially reduce the number of parts to be carried in stock at joint interlocking plants and will reduce the expense of construction and maintenance of such plants.

These appliances have been developed to such a point that the adherence to certain designs can be maintained with but few changes for a considerable period. Improvements in designs will necessitate a revision of some of the plans from time to time, but the adoption of standard designs should aid in discouraging the development of unnecessary appliances which mark no advancement, but do multiply the parts to be carried in stock and thus add to the expense of the maintenance-of-way departments.

Mounted and detail plans have been made of high and dwarf signals and lead-out cranks, rocker shafts, chain wheels and foundations.

Drawings will be made of the other apparatus used in the lead-outs and at switches and those parts of the tower necessary to show certain standard dimensions, applicable to the different sizes of machines to be provided for. No particular outside design for towers will be specified, as it is not considered expedient to have all towers of the same exterior appearance.

The dimensions of most of the plans of recommended designs are 15 inches wide by 20 inches long. Those plans which have different dimensions are made in the same proportion, namely, ¾ to 1.

The plans may be photographed down to any suitable size for publication in book form, while the tracings may be kept on file at the Secretary's office, where members may secure prints for working drawings on application.

The Committee has not yet come to a decision on the form of signal arm to recommend, although at least three designs are under consideration. It was the intention at first to recommend two different forms of signal-arm castings for interlocking purposes, one of which designs is shown on the drawings of mounted signals.

The latter arm is designed for a 70 degree arc of travel and to give two indications by position; the other arm was to be designed for a 90-degree arc of travel and to give two indications by position.

The large majority of railroads employ signals, the arms of which, in the clear position, form an angle with the signal mast, this angle varying from 15 to 30 degrees on the several roads.

A few roads of prominence use the signal-arm casting design for a 90-degree movement, the arms pointing down and standing parallel with the signal mast when clear.

The adoption of these two forms of arms would be in line with a conservative policy, for there is not a road of prominence in signal matters which could not adopt one or the other of these arms for interlocking signals and maintain the same relative positions of the arms for the indications to be given as is in vogue at present.

Should the Association adopt a two-position signal as standard for interlocking purposes it would be adding the weight of its authority to the inconsistent practice of having the distant signal arm for the caution indication and the home signal arm for the stop indication, both standing at right angles to the signal mast.

The only distinction made at interlocking plants between the home and distant signals for day indications is the form and color of the blades.

Several roads which use two positions of the arms for giving three indications at interlocking plants, namely, stop, caution and clear, use three positions of the signal arm for giving these indications at train-order stations.

It is evident that the best practice would be to have a distinct position of the signal arm for each indication to be given, and to have the indications the same for interlocking signals, train-order signals, station block signals and automatic block signals.

There is no mechanical difficulty in doing this; the precedents established and the cost for making the changes are the two principal features which stand in the way of the accomplishment of this result.

After considerable thought and investigation the Committee decided to look further into the matter and to secure the opinions of members of the Association before making any recommendation.

A plan is herewith submitted of a design of signal arm which will answer for interlocking signals, train-order signals, station block signals and automatic block signals.

The stop indication is given by the horizontal position of the arm, the caution indication by the diagonal position of the arm, the arm inclining below and forming an angle of 45 degrees with the horizontal plane; the clear indication by the vertical position of the arm, the arm pointing downward and standing parallel to the signal mast.

The arm casting is designed to carry glasses for giving the three indications at night, with the lamp located on top or at one side of the mast. The counterweight is applied around the lower spectacle and is effective in any position of the arm. A line drawn from the center of

the lower spectacle to the center of the arm bearing will not make a greater angle than 45 degrees with the horizontal when the signal arm is in the danger or clear positions. The spectacles are so arranged that either white or green may be used for the night clear indication, consequently a railroad using this type of arm may change from white to green without other expense than the cost of furnishing and putting in the green glass.

When used for interlocking purposes, two red glasses may be placed side by side, by which means a red light will be displayed at night, unless the arm is more than half way to the clear position.

The two latter features are also provided for in the signal-arm castings, designed for a movement through a 70-degree arc. These two features are important and should be provided for in whatever type of arm the Association adopts.

The Committee would like to have the opinion of the members on the desirability and practicability of adopting a single type of fixed signal for interlocking and block purposes.

It is not desired to have the Association take final action on the plans at this meeting. It is best to defer such action until all of the plans are completed.

The Committee, however, would be very glad to have the plans criticised and suggestions made, for if any changes in the methods are to be made, those changes should be determined now, as they would entail a large amount of work if made after all of the plans have been completed.

H. D. Miles, Signal Engineer Michigan Central Railroad, Detroit, Mich., *Chairman;*
T. S. Stevens, Signal Engineer Santa Fe Railroad, Topeka, Kan.;
C. Lewis, Assistant Engineer Baltimore & Ohio Railroad, Baltimore, Md.;
D. C. Morgan, Engineer Maintenance-of-Way Chicago & Alton Railroad, Kansas City, Mo.;
Committee.

Mr. H. D. Miles (Michigan Central):—The report of the Committee is brief, but I believe that it fully covers the difficulties which have been experienced, the character of the work to be performed, and what has been accomplished. The Committee, as stated in the report, has first considered the subjects in connection with interlocking plants, as that is undoubtedly the most important part of the Committee's work, as it affects jointly the majority of roads; and the most important part of that subject, it seems to the Committee, is the classification of standard specifications, standard appliances and rules on maintenance. The rules on operation of interlocking plants have not been considered by the Committee, because, as stated in the preliminary report made at the last annual meeting, it is a subject which should be considered by operating officials, and as

there were no objections made to that conclusion, the Committee has acted according to its original intention. The membership of the Committee has continually changed, the chairman being the only original member left.

Some work has been done on specifications and work will be done on rules for maintenance of interlocking plants. After those subjects have been considered, matters in connection with other branches of railroad signaling will be considered next. Three sets of blue prints are submitted of the drawings which have been made of lead-out material and signal apparatus used in connection with interlocking plants. The Committee considers that the important thing on which it should be advised at this meeting is on the design of a standard signal arm. It is specially important that signal arms should be of standard design for all roads. The position of the arm for the indication to be given should be the same for interlocking signals, station block signals and automatic block signals. The Committee has given some consideration to the subject, has made inquiries, and was finally able to secure a drawing from the Union Switch & Signal Company (recently made by some of its best engineers).

This arm casting is designed so it may be used for the three types of signals just mentioned, and the position of the arm for the indication given is explained in the report. The horizontal position of the arm would indicate danger; the diagonal position, caution, and the vertical position, clear. The Committee has not yet come to a decision on the matter, but it would be glad to have expressions of opinions from the members of the Association. While the Committee has not determined as to the recommendation to make, it nevertheless is favorably inclined toward the adoption of a three-position signal for all purposes, the indications to be given as mentioned above.

Mr. A. W. Sullivan (Illinois Central):—I ask whether or not the Committee recognizes the work which has been done by the American Railway Association through their joint committee on interlocking and block signals, in establishing requisites of installation, also principles and rules for the operation of signals? These rules have been adopted by that association and are now the standard practice. I would ask what effect that work has had on the work of this Committee, and what recognition the Committee has given to that practice.

Mr. Miles:—The report states that the Committee will give full consideration to all rules and recommendations concerning signaling which have been promulgated by railroad associations. The American Railway Association has adopted certain rules on operation which, as was stated before, it is not the intention of the Committee to consider, but the rules on maintenance and the specifications on construction recommended by said association will be carefully considered by the Committee when draughting maintenance rules and specifications. It is the opinion of your Committee, however, that the maintenance rules and specifications of the American Railway Association relating to interlocking plants, while covering in a general way the subjects, do not go enough into detail for the purposes of the signal engineer. It is therefore the purpose of the Committee to treat these subjects more in detail than the American Railway Association has done and has so treated them so far as the work has progressed. The Committee believes that there is no railway association which has done anything toward standardizing interlocking apparatus, and having gone into the latter subject quite thoroughly it is equally important that the standard specifications should be treated as much in detail as the former.

The President:—It seems to me that the function of the American Railway Association should be to determine everything that relates to the indication. They should determine the form and establish the position of the signals. I believe it should be the function of this Association to then determine the standard drawings or specifications and the mechanical construction and maintenance necessary to give expression to the indications required by the American Railway Association, which is supposed to control the matter from a transportation standpoint. What is your opinion of that, Mr. Sullivan? You are a member of that association and have had experience with this matter in that association.

Mr. Sullivan:—Probably, as you know—perhaps some of the members here do not—the committee on interlocking and block signals of the American Railway Association is a joint committee formed by combining the committee on safety appliances with the committee on train rules, and the two sit together and work together when considering any work relating to block sig-

nals and interlocking. The function of that committee has not been merely to provide rules for operation, but, what required much greater time and thought to determine, the essential requisites of installation. That has been gone into with great care and has been put in careful shape; the language has been weighed with great exactness and nicety, to have it express the precise meaning that the committee wishes to have incorporated in what it considers the essential principles. The rules that follow indicate the manner in which the operation of the signals shall be conducted and what the indications of the signals shall represent—how they shall be construed. I asked the question of the chairman of the Committee as a matter of information, in order that I might understand the status of the Committee on this work. I fully appreciate there is ample room for work of this kind, and what I desired to ascertain was if the Committee were working from these established principles—whether they recognize them as a basis for their own work, or whether they sought to go beyond them. It is quite necessary, in my opinion, in order to get the best results from association work, that the principles laid down by the experts in one association shall be recognized in another; certainly after they have received the approval of the association in which the work originated. In that way much time and labor is saved in not having to go over the same ground twice, and it gives to all who are interested the benefit of the ripest experience in that particular line of development.

Mr. Miles:—I think it would be a mistake for the Signaling Committee of this Association to do anything contrary to the work that has already been accomplished by the American Railway Association; and, as was stated before, it is not our intention to do so. There may be one or two things, however, which our Committee may feel should be altered on account of the developments which have taken place since the work of the American Railway Association was done, and I would like to ask Mr. Sullivan if he does not think that this Association should, in the matter of requisites of installation and rules on maintenance, go a little more into detail than the American Railway Association has done. As I understand it, the latter covered the subjects in a general way, while the aim of this Association is to go a step further and adopt standard apparatus and standard appli-

ances which could be used at joint interlocking plants and thus economies introduced on account of the adoption by many roads of like specifications and like appliances.

Mr. Sullivan:—I did not wish to intimate that there is necessarily any conflict between the work of this Committee and the work of the other association. There need not be, and I hope there will not be. The work which the American Railway Association has sought to do is to establish the fundamental principles of signaling. The manner in which those principles shall be given physical expression it has not gone into, and that is a phase of the work to which we should give careful attention. This matter should be carefully considered by some body of men, and I do not know of any better qualified to handle it than the Committee on Signaling and Interlocking of this Association. Of course, the preparation of the specifications and everything relating to maintenance is pre-eminently a matter which this Association should deal with. I do not wish to appear in the attitude of criticising the Committee, and I have made these remarks with a view only of securing more general information on the subject by all concerned. This is practically the first report of the Committee, and a proper understanding of the scope of its work would no doubt help the members of the Association generally to understand what to look for in its reports.

Mr. H. G. Prout (Chief Editor Railroad Gazette):—I would like to suggest an idea, which is not exactly pertinent to this report, but which is interesting. That is, the time may come when the American Railway Association will be the head of these various associations; for instance, of our Association, the Master Car Builders, the Master Mechanics, and perhaps some others, and an effort might be made to co-ordinate the work that has been done by these separate associations. I know that when Mr. Loree was elected as president of the American Railway Association he was much taken with that notion, but I doubt if anything has been done in that direction, and it is very possible that nothing can be done. I thought it was an interesting idea to suggest, as no doubt a good many of the gentlemen here will sooner or later be members of the American Railway Association, and this is something for them to think about.

More particularly with regard to this report, it has struck me that possibly the time has hardly come for standardizing many of the details of interlocking and signaling, for the change which is going on in that sort of apparatus is pretty radical and pretty rapid. For instance, I imagine we may reasonably look forward to getting rid of disc and banjo signals before many years pass, and the substitution for them of automatic semaphores electrically operated. I suppose that is sure to come in. I have not a word to say against the disc and banjo signals, because I recognize their great utility in service, but we are in a transitional period, a period when it would be dangerous to try to do much in the way of standardizing the apparatus until we have first standardized its functions. I suggest this from the depths of my ignorance on the subject.

Mr. C. L. Addison (Long Island):—As I understand this subject, the Committee desires the Association to attack a signal which is as well known as the home signal. The functions of this signal have been recognized and set forth clearly by the joint committee on block signals and interlocking of the American Railway Association. It is a radical departure to attempt at this time to eliminate the distant signal. As I understand the Committee, this signal would be eliminated if their recommendation was adopted. I ask for information on this point.

Mr. Miles:—I will say that it is not proposed to eliminate the distant signal at interlocking plants. The question which the Committee would like expressions of opinions upon is the desirability of having the day indications for danger, caution and clear, respectively, given by the horizontal, diagonal and vertical positions of the signal blade, or in other words, instead of following the present practice of having the horizontal position of the home signal arm indicate danger or stop, and the horizontal position of the distant signal arm indicate caution, to have the horizontal position of all blades indicate danger or stop, the diagonal position of all blades indicate caution and the vertical position of all blades indicate clear. While it would not be necessary to have different forms of blades to distinguish the home from the distant signal at interlocking plants and to distinguish interlocking signals from block signals, there would probably be some advantage in having different forms of blades to aid in distinguishing such signals.

Mr. Addison:—Do I understand normal position of the distant signal is to be 45 degrees?

Mr. Miles:—That was the question which the Committee would like to have the Association discuss. It is not our settled idea. We would like your opinion upon it.

Mr. A. S. Markley (Chicago & Eastern Illinois):—We have some trouble in keeping them adjusted in two positions, and with a third position it would seem almost impossible to do it.

Mr. Miles:—The distant signal has only two positions, 45 degrees and 90 degrees.

The President:—The Committee should continue its investigations of this subject and give very close consideration to the recommendations of the American Railway Association, and confine its work, as Mr. Sullivan states, to the mechanical expression of the ideas outlined by that association, and we should not as an association make any change from what the American Railway Association has recommended as fundamental principles.

We will now take up the report of the Committee on Records, Reports and Accounts. In the absence of both the chairman and vice-chairman of the Committee, we will call upon Mr. MacPherson to introduce the report and make his comments in relation thereto.

REPORT OF COMMITTEE XI.—REPORTS, RECORDS AND ACCOUNTS.

To the American Railway Engineering and Maintenance-of-Way Association:

In the following report reference is made to the classification of Operating Expenses, recommended by the Interstate Commerce Commission. This is taken as a basis, because, while perhaps few roads have adopted it as a whole, it is coming into larger use every year, and every road making a report to the Interstate Commerce Commission has to transform their accounts into the form required by the Commission; State Commissioners are also requiring reports very similar to the Interstate Commission, and a vast amount of work would be saved in railway offices if these reports could be filled out without working over a year's results kept in some other way.

The Interstate Commerce Commission divides operating expenses into four principal heads, viz.: No. 1—Maintenance-of-Way and Structures, with ten subheads; No. 2—Maintenance of Equipment, with nine subheads; No. 3—Conducting Transportation, with twenty-seven subheads; No. 4—General Expenses, having seven subheads. These subheadings can

be again divided to suit the particular requirements of any railway using the system, but such subdivision is not required by the Commission.

SECTION 1—LABOR REPORTS.—In submitting the following report, especially that part relating to Labor Reports, your Committee does not wish to be understood as recommending that the only labor reports should be made in form of Time Books. It is often convenient, and sometimes necessary, to have daily reports by wire or mail, in order to keep close track of important gangs, but all such reports should be in addition to the full and complete report at the end of the month or week, from which the payrolls are made up. These reports should be made by means of Time Books. There should be but two forms of Time Books in the Maintenance-of-Way Department—one for Section Foremen, and Foremen of Extra Gangs, and one for gangs in the Bridge and Building Department. These should be of sufficient size to keep the time of the gang for one month only, and should be made of paper on which ink can be used; preferably, a light shade of yellow, and bound in heavy paper covers, and of such size that they may be conveniently sent through the mail. On the cover should appear the name of the railway, and the division on which it is used, the name of the foreman, the month and year for which it has been used, and in case of section gangs, the number of the section, and limits of same.

The book used by Section Foremen should give one double page to each man, whose name should appear on the top, on the left; on the right, the month and year; on the left-hand page, under heading of "Work Done," should be printed a list of the various kinds of work that are usually performed by Section and Extra Gangs, and these should be grouped under the headings recommended by the Interstate Commerce Commission. Each of these subheadings should have a line running across both pages. The space immediately to the right of these printed headings should be ruled off into thirty-four columns; one for each day of the month, numbered at the top from one to thirty-one; one for total time worked; one for rate per day, or hour, and one for amount.

These columns should be long enough to cover all the printed headings and a few blank lines for "Miscellaneous Work;" below this should be a space left blank for Remarks, Board Bills, etc.

The Time Book for Extra Gangs should be of the same form as that for Section Gangs, but should have pages enough to take in the largest gangs worked. On the inside of the cover should be printed instructions as to the manner of keeping the book, and directions as to disposition of book at the end of the month.

The Time Book used by Bridge and Building Gangs, should be wider than that used by Section Foremen; but, like that one, should give one double page to each man, whose name and occupation should appear at the top of the page, to the left; and on the right, the month and year.

The pages should be ruled from right to left; the left-hand page should be divided into three wide columns; the one on the left headed "Location of Work;" the heading of the next column should be "Structure on which Work Was Done;" that of the third "Description of Work Done."

Time worked by

In month of 190

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total Hours Worked	Rate per day or hour	Amount
Regular Mechanics																																		
Helpers Laborers																																		
Painters																																		
Plasterers																																		
Bricklayers																																		
Carpenters																																		
Painters																																		
Total days or hours																																		

Remarks

Bonus Bills

ation

Rate per

So.	8	9	10	11	12	13	14	Amount
R								

Time worked by

Occupation

in month of 190

Rate per hour

Location of Work	Structure on which work was done	Description of work done	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total hours worked	Rate per hour	Amount

The right-hand page should be divided into thirty-four columns, having same heading as in Section Foreman's Time Book.

Below these columns should be a place for Remarks, Board Bills, etc. On the inside of the cover should be printed instructions as to the manner of keeping the book, and directions as to disposition of same at the end of the month.

Sample pages of each of the two kinds of time books recommended are submitted herewith.

MATERIAL REPORTS.

"Various Forms Used in Reporting Material Used, to Enable Complete Check to Be Had on All Material Used."

A study of the blank forms for reporting material collected by the Secretary of this Association shows that, while there is some similarity of practice, there is also great diversity. On all, or nearly all, the roads that reported, the track men use a different set of blanks from those in use by men employed in the Bridge and Building Department. On some roads, all material used in maintenance-of-way, exclusive of structures, is reported on one large sheet, which also includes Tool Report; others cut out all the larger items, such as ties and rails, and make reports of this material on separate blanks. Where separate reports are made, the information given is much more complete. While most roads use blanks of some form on which to report material, others report, part at least, in the Time Book, some pages being ruled as blanks for this purpose.

Most of the blank forms mentioned above provide for reporting the material of each kind on hand at the beginning of each month; amount of each kind received, and amount used during the month. A blank of this kind properly filled out enables a close check to be made on the material at the division, or general office, where invoices and Storekeeper's statements can be referred to. In addition to the material reports from which the accounts are made up, there are many which are simply for information, such as those stating where rail has been laid, fence built, ballast put in, etc. These are all necessary, to keep a record of the condition of the property, but do not affect the accounts.

MISCELLANEOUS REPORTS.

Such as Accidents, Fire Claims, Stock Killed, Flood Damage, Etc.

Accident Reports are, generally speaking, of two kinds; one is a report of an accident whereby any damage is done, and may cover injury to or loss of life; the other is a personal injury report, which, while it is the result of an accident, generally requires a separate report.

The Maintenance-of-Way Department is generally called upon to furnish reports of all accidents, but is seldom asked to furnish personal-injury reports, excepting so far as they relate to persons killed, or injured, who are in the employ of the department. Reports of stock killed or injured, damage by fire, flood or wind are always required of foreman in the Maintenance-of-Way Department. In some states there are laws

prescribing the form of some of these reports; with these last, this report will not deal.

Of the blanks collected by the Secretary of the Association, the largest number can be classed under the heading of "Miscellaneous," including accident, personal injury, fire claims, stock killed or injured, etc.

There is a great variation in what is required in these "Special Reports;" some roads prescribing but few questions and combining the report to facts alone, while others print over fifty questions, asking for facts and opinions as well.

Most of these reports are made by Section Foremen, who, as a rule, regard the making of a report as a harder task than a day's labor, and their value, generally, bears an inverse ratio to their length.

RECORDS.

(a) Right-of-Way Records, Deed Records and (d) Alignment Records.

RIGHT-OF-WAY AND DEED RECORDS.—The person or department in whose custody right-of-way papers or title deeds are placed, should make a direct or grantor index of the same in alphabetical order in a book of convenient size, containing columns for the entry of

Deed number,
Date of deed,
Grantor,
Grantee,
Kind of deed (warranty, quit claim, etc.),
Consideration,
Description in general, thus:

S. E. ¼ of S. W. ¼, Sec. 20, T. 57 N., R. 35 W., Buchanan County, Mo., with separate columns for lots, blocks, sections, townships and ranges.

Where recorded, book, page, county and state.

The form proposed is shown herewith.

Deeds should be numbered consecutively from 1 up, as they are handed in, then forwarded to the proper officer to record on right-of-way maps, by him to be returned to the Custodian of Deeds with a notation thereon that deed has been properly entered, after which deed should be filed in numerical order in a secure place.

As the deeds are forwarded from the custodian to the person or department in charge of right-of-way maps, they should be entered in a book for this purpose, being divided into columns for the entry of

Deed number,
Subdivision or addition,
Section or city,
Township,
Range,
Lot,
Block,
Date of deed,

Recorded, book and page,
Grantor, and
Grantee,
on the left-hand page, and on the right-hand
Date of entry on right-of-way maps,
Plat of ground, and
Abstract of deed.

Sample pages of proposed index book are shown herewith.

The abstract of the deed entered on the right-hand page should be as short and concise as possible, while giving all essential information, so that it will be necessary to remove the deeds from their files as infrequently as possible, and then only in important cases.

Deed should be entered in this book under counties, and in the order that the line crosses townships for north and south lines, and in order of ranges, for east and west lines, or in those states not so divided, in the order that the railroad line crosses municipal townships or towns.

Care should be taken not to crowd the entries, so that subsequent purchases may be entered properly. In case this cannot or is not done, reference should be made in the proper place to the page on which such deeds are to be found.

RIGHT-OF-WAY MAPS.—Right-of-way maps, except in cities and large towns, should be drawn on a scale of four hundred feet to one inch. They should be made in separate sheets for convenient handling, the length being determined generally by the size of the printing frame, and the width need not exceed twelve inches.

They should be bound loosely in board covers in such a manner that sheets may be easily removed, corrected and replaced, and the name of the road, branch or division should be printed on the cover.

Right-of-way maps should show the state, county, municipal township, city or town, as also the congressional divisions of township, range, section and quarter section, which latter should be divided into quarters; the right-of-way, alignment with all curve data, numbers of and plusses to all culverts and bridges, location of all mile-posts, depots and important buildings of the company, the larger streams and rivers which cross or are adjacent to the line of the road, as, also, all important natural conditions near or on the right-of-way; the plusses of the crossing of all important land or property lines and streets, with distances to all permanent or well-defined land or street corners, the angle which the center line of the road makes with land and property lines, the true bearing of all tangents, when obtainable, a notation in pencil as to the date to which the sheet is corrected, the number of the right-of-way sheet, the points of the compass and the scale of the map.

The boundaries of the several parcels of land owned by the company should be shown by black lines on the face of the map and colored yellow or red on the under side, so that it will show distinctly on a print,

or the land may be shown by hachure lines, adjacent parcels conveyed by different persons being distinguished by lines at different angles.

On or near each parcel of land should appear the Deed Custodian's number, with name of grantor, date, book and page of County Recorder, and any unusual conditions appearing in the deed.

The width of right-of-way should be frequently and clearly shown on each side of the center line of road, particularly at those points where the widths change.

Reference to long time or important contracts should be made on these maps in a similar manner to that for deeds.

Right-of-way or lands owned in cities or towns should be shown on station plats, as described under that heading.

Station Plats.—Station plats should be made in a scale of one hundred feet equals one-inch sheets, the length of which is generally determined by the length of the printing frame, and the width varying from twelve inches to the width of the frame.

For the larger cities the sheets should be bound together, the remaining or way-station plate being arranged in station order and bound so that separate sheets can be removed, corrected and replaced.

The name of the station should appear on each sheet, and in addition to the information recommended for ordinary right-of-way maps, the plat should show the additions or subdivisions of the town or city with numbers of lots and blocks, names of streets, the dimensions of the boundaries of right-of-way or property of the company, width of all streets, lots, blocks and out-lots shown on the map, dimensions of all buildings and other structures owned and of what constructed.

Each track should be shown by two lines and its distance center to center from adjacent track. Frog numbers should be shown for all important tracks, and for those tracks leading out of the main line, point switches should be designated by the letters P. S. and stub switches by the letters H. B. with the station number and plus.

Tracks should be numbered or named to correspond to the operating names or numbers for convenience in reporting changes of tracks.

Profiles of Road.—Profiles should be in rolls from ten to twenty miles in length, using generally from one-third to one-half the width of profile as it comes from the manufacturer.

The profile should show the station numbers and mile-posts of the constructed line, the surface of the ground prior to the grading of the line, the established grade line, the rate of grade for one hundred feet and for one mile, the location and elevation of those points where the grade changes, the alignment of the road, tangents being shown by a horizontal solid line and curves by a horizontal broken line, with the degree and direction of curvature and total angle consumed; also location, number, size and materials of construction of all water openings, cattle passes and roadways, the location and elevation of all railroads or

R. R. Co.

ber	Month	Section	Twp.	Range	Lot	Block	Recorded Book	Page	County	State
41	Feb.	4	57	35			29	141	Buchanan	Mo.
42	July						29	120	Buchanan	Mo.
		1	56	34						
		2	56	34						
43	Jan	4	57	35			29	160	Buchanan	Mo.
44	July	10	57	35			16	141	Buchanan	Mo.
45	apr	4	62	41			14	27	Pottawattomie	Ia
46	Mar				1	20	13	69	Macon.	Mo.
					2	20				
					8	20				
					9	20				
					6	21				
					7	21				

REGISTER OF TITLE DEEDS

X Y & Z R.R Co.

Number	Date Month	Day	Year	GRANTOR	GRANTEE	Kind of Deed	Consideration	Description	Section	Twp	Range	Lot	Block	Recorded Book	Page	County	State
1	[illegible]	9	1871	Sorrells, Geo. B	X Y & Z R R Co	Warranty	500 00	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
102	July	24	1861	Sargent S P L	Mutual Life Ins Co	Warranty	200 00	All of the following named sections lying east of the center line of M V R R Co	1 12	38 38	3W 3W						
1413	Jan	6	1871	Bailey, Colin W	X Y & Z R R Co	Q C	50 00	50 ft wide [illegible]	[illegible]	[illegible]	3W			[illegible]	104	[illegible]	[illegible]
1414	July	9	1869	Samuels, Jacob	L T Jones Trustee	Warranty	1400 00	Right of Way and Station Grounds 200 ft in width on N Side	20	5S	3W			102	[illegible]	[illegible]	[illegible]
1415	Apr	10	1872	Sangrann, Antonio	L M Porter, Trustee	R W	65 00	right of Way across on [illegible] side	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
1416	Mar	11	1871	Sanger, John P	X Y & Z R R	Q C	1,500 00	All of the following lots are blocks within 25 feet of the center line of the main track as located through the city of Madison. Main St				1 2 3 4 5	25 25 25 25 25	[illegible]	[illegible]	[illegible]	[illegible]

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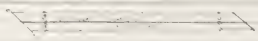
RECORD OF TITLE DEEDS, X.Y.&Z.R.R

CLARKE COUNTY WASHINGTON.

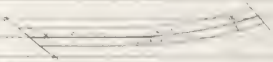
Number of Deed	LOCATION: Subdivision or Addition	LOCATION: Section or City	Twp	Range	Lot	Block	Date of Deed: Mo	Day	Year	Recorded: Book	Page	GRANTOR	GRANTEE	Entered on map	Plat Abstract and Remarks
44	N½	2	14	27			7	14	93	6	7	S P Young	J. W. & E. S.		
60		11	14	28			8	9	92	8	14	L. J. Mclnnes	X. W. & E. R.		
34	S½ of W½	12	14	29			6	4	01	6	27	[illegible]	X. W. & E. R.		
21	Smiths Addn	Vancouver			2	4									
					3	4									
					4	4									
					12	4									
					13	4									
					14	4									



Consideration "30"

Description will also read S the S ½ of same which lying within 1 ½ rods of the center line of the X. W. & E. R. Railway as now located

Conditions Covenants & restrictions as to future use as private residence only

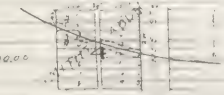


Consideration "225"

Description: The Remainder East of said R. R. right of way

No Conditions

So much of said Early West tract as lies within forty feet of the center line of the X. W. & E. Railway as located on the Thirteenth day of March 1907 from the south line of said tract and parallel with said center line for a distance of four hundred and fifty feet more or less to the west line of said tract



Consideration $600.00

"All of the above described lots lying within twenty feet of a curve line described as follows Beginning at a point on the boundary line between the south of the north west corner of Block four in Smith's addition to the city of Vancouver, Clarke County, Washington and running thence Southerly curving to the westward on a radius of two thousand eight hundred and sixty five (2865) feet to a point two hundred and eighty two (282) feet south of the north east corner of said Block"

ECORD OF LEASES.

Authority to Execute	EXECUTED LEASE From Gen. Supt	EXECUTED LEASE To Auditor	RECEIVED BY	No of Lease	Entered on Lease Maps	REMARKS.
12-20-00	12-31-00	12-31-00	B. L. Crosby	2341	12-16-00	Cancels 1366
10-1-00	10-9-00	10-9-00	B. L. Crosby Jr.	2287	9-22-00	Cancels —
3-20-00	4-5-00	4-5-00	B. L. Crosby Jr.	2350	2-28-00	
2-16-01	3-1-01	3-1-01	B. L. Crosby Jr.	2411	2-13-01	Cancels 1442
12-11-00	12-28-00	12-28-00	Ben L. Crosby Jr	2345	11-17-00	Cancels 753

X Y & Z R R. – VERMONT DIV

RECORD OF LEASES

FROM	DATE	LOCATION	WITH WHOM	LSE	WORKS		DATE CLOSED	FROM	DATE LEASE MADE	DESCRIPTION		RENT		RELEASED BY		REMARKS
					Name	Class				Acres	Rods	Per	Amount			
MPH	1	7:00	Putney Va.	Penmore L & W Plant	Coal Dock	Ether								C. Putney		
Fy.	2	6:00	Fairway	A.J. Denny	Pasture	N&W				9	435			A. J. Denny		
MHS	2	9:30	Mayfield	Union Dairy Co	Ice Ho	Ether				3	225			H. Mayfield		
MHA	3	9:00	Brookfield	Standard Oil Co	Oil Plant	B&M				4	76			H. J. Conway	2	
MHN	11	5:00	Cummin	Anheuser Busch Brg.	Brew. Plant	B&M				3	435			H. J. Conway	24	Cancels 11-03
														H. J. Conway		Cancels 7-10

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X. Y & Z R. R.

CONTRACTS AND LEASES.

Number	Name of Road	With Whom	Nature of Document	Date	Expires.	No. of Canceled Contract	Memoranda
2596	X + Z. R.R.	Wolverine Lumber Co	Land Lease	8 1 96	2 1 09		
2597	Z. Midland	Stoddard Oil Co.	Lease of Land - Liberty	8 6 96	5 6 99	1523	
2598	Y. Valley R.R	Mason & Diddell	Grading - Y Valley Branch	10 4 97	10 4 07		
2599	X. Y & Z. R.R	C. B. & Co.	Cast Iron Car Wheels	6 6 97	6 6 00		
2600	X. Y & Z R.R	St Charles Car Co	Lease of Cars	1 4 97	1 4 06	1641	
2601	Z. Midland	Rent of Office	Rent of Office Building Nail	7 9 97	7 9 00		

X Y & Z R.R.

RECEIPTS FOR CONTRACTS AND LEASES REMOVED FROM FILES

Number	Name of Road	With Whom	Receipt	When taken	When Returned
2596	X. & Z R R	Wolverine Lumber Co.	H.B. Hiring	6 4 98	6 6 98
45	Z. Midland	Pullman P. Car Co	John Sharp	6 6 98	7 5 98
2599	X. Y & Z Ry	O.B. Child	Henry Bull	6 9 98	6 11 98
2600	X. Y & Z R.R	St Charles Car Co	C. A. Countant	7 4 98	7 5 98
31	Z. Midland	Arctic Ice Co	N. O. Borden Jr.	7 6 98	8 9 98

X Y & Z R.R

RECEIPTS FOR CONTRACTS AND LEASES REMOVED FROM FILES

Number	Name of road	With Whom	Receipt	When taken	When Returned

X Y & Z R R.

REFERENCES TO CONTRACTS AND LEASES SHOWING DATE OF EXPIRATION.

JANUARY

1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
641	1492	2596	2600	1941	2391											
1638	1701	2643		1621	2716											
1640	1924	2981		27	2698											
		3101			2313											
					2941											

X Y. & Z. R R.

REFERENCES TO CONTRACTS AND LEASES SHOWING DATE OF EXPIRATION

FEBRUARY

1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
1645	1691	2645	2596	2306												
1662	1709	2981		2719												
		2981		2700												
		3401		2517												

roads crossing under, over or at grade, the names of all important streams or rivers with the elevations of standard and extreme high and low waters, and any other important natural or artificial physical condition along, or crossing the right-of-way of the road.

LEASE RECORDS.—Leases should be numbered and filed in numerical order by road, branch or division. They should be filed in a secure place.

The Custodian of Leases should keep a lease record book containing in the body of the book columns for the entry of

Number,
Name of Road, Branch or Division,
With whom,
For what purpose,

on the left-hand page, and on the right hand

Date when lease takes effect,
Date of expiration,
Date of entry in back of book under year and month of expiration,
And a column for memoranda, showing to what officer and when the Custodian wrote of the expiration of lease.

In the back part of the book a few pages should be used for the purpose of keeping a record of leases removed from the files, and each page should be ruled in columns as follows:

Number,
Name of Road,
With whom,
Receipt (name of borrower),
Date when taken,
Date when returned.

Other pages in the back part of the book, twelve pages for the twelve months, should be ruled into columns for years, and immediately after the receipt of a lease and its being entered in the body of the book, the lease number should be entered under the year on the proper month page when it expires.

The names of the lessees should be indexed alphabetically in the front of book, as, also, should each lease be indexed by the station name.

Samples of the different pages are shown herewith.

The person or department who furnishes the description and makes the leases should have a lease record book ruled in columns for

Notice of application for lease, from whom and date,
Location,
Name of applicant,
Use,
Work of getting description, given to whom, and date,
Description furnished,
Application from General Superintendent (or other officer),

Date lease made,
Lease copied in impression copy lease book, book number and page,
Date forwarded to Legal Department,
Date of lease,
Date of expiration,
Copy to (Resident or Local Engineer) and date,
Authority for execution given,
Date executed lease received from General Superintendent (or other officer),
Date executed lease forwarded to Custodian of Leases,
Lease receipted for, by whom,
Number of lease,
Date entered on lease maps, and
Remarks.

Sample page of proposed book is shown herewith.

All executed leases should be entered on lease maps. For this purpose blue prints of station maps should be used for leases at or near stations, and line or right-of-way maps can be used for leases between stations. The prints should be loosely bound in station order, in board covers, with the name of the book and the line or portion of line on the outside.

Each executed lease should be entered on the lease map in strict accordance with the description in the lease, and all dimensions given therein should be shown, and there should appear the

Lease number,
Name of Leases,
Use,
Date of expiration, and, in the right-hand lower corner,
Date to which map has been corrected.

It is recommended that duplicate copies of record books and maps, particularly right-of-way maps, should be kept in quite widely separated localities, so that the trouble and expense of reproducing the same will be greatly reduced in case of fire or accident.

Owing to the somewhat limited time available for necessary investigation and writing, the report under Section 2 of the items assigned this Committee, it was impossible to examine into the practice of but very few roads; it is hoped, however, that this may be done for future reports.

SECTION 3—(a) and (b)—LABOR AND MATERIAL ACCOUNTS.

By Joseph Morrison.

The classification of the distribution of the accounts for labor and materials used in the Maintenance-of-Way-Department, as well as in the various other departments of American railways, has been a matter of very thorough investigation and careful consideration by the Association of American Railway Accounting Officers for several years.

The results of their investigation have been issued upon the authority of the Interstate Commerce Commission.

It may be said that this classification represents the best thought of the Railway Accounting Officers and Commissioners of the United States.

This general classification, with perhaps some slight modifications, is no doubt being adopted by the principal railway companies of the country, and your Committee gladly records itself as fully supporting the recommendations of so distinguished and representative a body.

Here follows the classification of accounts for Maintenance-of-Way and Structures:

1. Repairs of Roadway.
2. Renewals of Rails.
3. Renewals of Ties.
4. Repairs and Renewals of Bridges and Culverts.
5. Repairs and Renewals of Fences, Road Crossings, Signs and Cattle-Guards.
6. Repairs and Renewals of Buildings and Fixtures.
7. Repairs and Renewals of Docks and Wharves.
8. Repairs and Renewals of Telegraphs.
9. Stationery and Printing.
10. Other Expenses.

This classification is a very flexible one, and may be modified to suit the requirements of managing officers without detriment to the general result.

For instance, under heading No. 1—Repairs of Roadways—it might be desirable to separate the accounts for Superintendence or for Ballasting Track. This can easily be done by arranging subheads, as

1a. Superintendence.
1b. Ballast and Ballasting, etc.

H. F. WHITE, *Chairman*, Burlington, Cedar Rapids & Northern Railway, Cedar Rapids, Iowa;
JOSEPH MORRISON, *Vice-Chairman*, Central Vermont, St. Albans, Vt.;
L. F. GOODALE, Chief Engineer Burlington's Missouri Lines, St. Joseph, Mo.;
T. J. FRAZIER, Baltimore & Ohio Railroad, Zanesville, Ohio;
D. MACPHERSON, Canadian Pacific, Montreal, Can.;
HENRY ROHWER, Missouri Pacific, Sedalia, Mo.;
GEORGE HOULISTON, Pennsylvania Railroad, Buffalo, N. Y.;
Committee.

Mr. D. MacPherson (Canadian Pacific):—It was a nervous shock to me to be told a few moments ago that I was the only representative of this Committee present. I had hoped the chairman or vice-chairman or some of the other members of the Committee would turn up, and I felt that after having done what little I could to assist in the preparation of the report, my only duties

would be to sit behind this table and look pleasant while the chairman was being criticised. Under the circumstances it may perhaps be pardonable to explain that while not claiming special fitness for any of the committees, I will say that if there was one committee more than another on which I was not qualified to shine, it was the one on which I now find myself elevated to such a pinnacle of publicity. Having this greatness thrust upon me at a moment's notice, I would beg leave to claim the politician's privilege of taking all your remarks into serious consideration and deferring my replies till a more convenient date, and after I have consulted with my colleagues. After making all these excuses it need scarcely be added that our report is a mere skeleton; but I trust its many shortcomings may be counterbalanced by the wisdom of your discussion.

Mr. W. McNab (Grand Trunk) :—I consider the report very complete in regard to forms for keeping various records and do not wish to criticise it further than to make a suggestion. On page 6 it recites what the profile should show. I presume this refers to the finished profile made after the line is completed. It says it should show the surface of the ground prior to the grading of the line. I think it would be well to put on the profile also the various classes of material gone through in the cuttings, for it frequently happens that in widening for double track the work is done by the railroad company itself, and it would be well to give the classification of material in more detail than is given in the ordinary specifications which generally classify simply as earth, loose rock, and rock, so that it would be of use when the railroad comes to doing any of the work of widening the roadway, such as in putting in a double track or sidings. In regard to showing the ditches on the land plans, I presume on a well organized railroad the original land plan is never altered or supplemented with any other drawings or information, because it frequently happens that legal matters come up after the road has been built and in operation, referring to road crossings and ditches, concerning which the original conditions must be referred to.

In regard to ditches, it would be well to have elevations of important ditches a little distance on each side of the railway track placed upon the map, so that in the event of their being

subsequently deepened by the farmers or the municipalities, and these individuals or communities calling upon the railroad company to bear a share of the work—perhaps an undue share—the original features of the ground and water courses when shown in a court of law might frequently have a valuable bearing on the liability of the railroad to contribute toward the object.

In reference to the form suggested for keeping a record of leases, I would recommend that another column or columns be inserted in order to take in the names of those to whom the leases may be assigned. A lease may be made of a piece of ground for a storehouse or some other purpose, and perhaps in one month afterward it may be transferred or assigned to someone else, and this may go on two or three times in a year, so that there should be a proper column or columns for keeping record of these transfers.

I do not know whether it is in the province of this Committee to take up the matter of the most systematic method of indexing the records of the plans—land plans, profiles, plans of buildings, bridges, and such structures that are in charge of the chief engineer or chief maintenance-of-way officer, but those who have had experience in getting the plans of subsidiary roads thrust upon them to catalogue and index know the difficulties that have been undergone in putting them in ship-shape. And if it is within the province of this Committee to take up the question of a standard method of indexing or card cataloguing, and the most systematic method of placing plans, I think it would be well if at the proper time they would keep that in view.

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis):—There is one more point in regard to this subject, and that is as to rights-of-way that are condemned. The Committee here seems to have overlooked the fact that titles to right-of-way are frequently obtained through decrees of court. Unless the real estate department or the chief engineer has a transcript of such decrees, it is an extremely difficult matter to keep track of them. Some provision should be made for the care of these decrees of the chancery courts, as well as other deeds.

Mr. E. E. R. Tratman (Resident Editor Engineering News, by letter):—It is very desirable that the number and style of

reports should be reduced and systematized as far as possible, to reduce the labor of filling in and of filing them, and to make the information given more available. They should be of as few sizes as possible, and it will often be possible to combine two or more reports in one. I have in mind a set of three separate monthly report blanks for new and second-hand rails laid and renewed on main and sidetrack, which might easily be combined in one sheet of the same size. This would be more easy to fill out, more easy to file, and would show the results at a glance.

The President:—Any further remarks on this report? If not, we will excuse the Committee and call the next—the Committee on Signs, Fences, etc., Mr. Bontecou, chairman.

REPORT OF COMMITTEE NO. IX—SIGNS, FENCES, CROSSINGS, ETC.

To the American Railway Engineering and Maintenance-of-Way Association:

This report is confined to matters mainly related to the safety of highway surface crossings.

It is believed that little consideration need be given by the Association to the numerous crossings of country roads on which travel is infrequent, and where no special sources of danger exist. Although in certain sections, where trains are numerous and highway traffic heavy, there is a tendency to the gradual elimination of all surface crossings, the operation of a very large part of our railroad mileage causes few accidents at the less dangerous crossings, and the prospect of any general and radical change of methods is quite remote.

The theory of protection on which the state laws and, of course, railroad practice proceeds is to warn persons near the crossing of the approach of a train, by sign, whistle and bell, and then depend on them to avoid it.

The whistling post on single track lines is always located on the engineer's side, about a quarter of a mile from the crossing and the sign so as to be conspicuously seen from the highway. The form of the sign is necessarily modified by the requirement of the prescribed lettering, and it is not deemed desirable to recommend a standard form.

The physical condition and arrangement of the crossing should be such as to facilitate the passage of a vehicle in the shortest possible time, and with the best possible view of the track. The planking should be smooth, the drainage good, and the grades easy. In the case of those crossings where, for any reason, the whistle and bell cannot be heard, or the approaching train seen, the electric alarm bell has been resorted to with

satisfactory results, giving adequate protection in some locations, when without its aid the expense of a watchman would be necessary.

The concensus of opinion from the fifty railroads answering the Committee's circular might indicate some diversity of opinion as to the efficiency of bells, since only thirty roads use them. Of these, however, the three that disapprove and eight that express no opinion have had a limited experience, while the nineteen roads that find them satisfactory include those that have used them most extensively. The important objection to automatic bells is the possibility of failure and the increased liability of the railroad when a failure leads to an accident. There is, of course, a certain percentage of failures, and their number depends largely on the thoroughness of the methods of inspection and maintenance. Information as to the number of failures is limited to a few sources, but these show that bells operated by track circuit may be depended on not to fail oftener than from once to twice in a year. One road, for example, reports the use of thirty-seven track circuit bells, which failed fifty times during the year, and thirteen bells of other types which failed fifty-five times during the year; eighty-five per cent. of the failures being due to causes other than malicious interference.

The statements made by the twenty-seven roads that are using bells do not justify a settled opinion as to type, and hardly admit of tabulation. It may be considered, however, that the bells should give at least thirty seconds' warning of the approach of any train, and be equipped with a twelve-inch gong that should ring continuously when the apparatus is out of order. The number of failures is reduced by doubling the bond wires when operating by track circuit. The inspection should be both frequent and intelligent. Station agents or section foremen should examine daily and repairmen frequently; reports in both cases being sent to division headquarters.

The cost of installing bells varies from $125 to $500, and of maintaining them from $10 to $40 per year.

When the railway and highway traffic become considerable, watchmen and, on important streets, gates are necessary. At this point crossing maintenance becomes expensive, but there is no criterion by which to decide when it has been reached, other than the judgment of railroad officials or the demand of the municipal authorities, and in most cases the latter act first.

The duty of the crossing watchman is simple and obvious, but his responsibility large. He is expected to prevent accidents at his crossing by giving warning of the approach of trains and handling gates where they are provided. He is usually required, in addition, to keep the crossing clean and the flangeway clear. His instructions are confined to those duties by most railways, and some require him to flag trains over the crossing. It is evident that no further duties should be imposed which might detract from his efficiency in preventing accident. The watchman must himself be sure at all times of the conditions under which he is working, and should be warned by automatic signal of approaching trains wherever the location makes it necessary.

Answers to the Committee's inquiry about merits and construction of gates were received from forty-three roads, and show a preference for some form of gate operated by compressed air, with either mechanical or pneumatic underground connections. These answers do not justify discrimination against mechanically-operated gates in locations for which they are suitable, but it may be concluded that wherever quick handling is desirable, or where it is practicable to work gates at two or more points from one tower, the pneumatic power will prove the most efficient.

The essentials of good service are thorough drainage and air-tight connections. The best galvanized iron pipe should be used, laid in wooden trunking and tested for leaks. With these conditions filled, climate does not materially affect the operation of the gates. The cost of gates per set is approximately as follows:

Crank gate	$275.00
Air gate, mechanical construction	300.00
Air gate, pneumatic construction	325.00
To which must be added cost of erection, about	60.00
Cost of gate house (or in case of elevated tower additional)	$50.00 90.00

Any crossing is doubtless made safer by being lighted, and most railroads assent to the proposition that where the traffic is heavy they should be lighted. The necessity is practically determined by municipal authorities. Where the crossing is near a yard an electric arc light is objectionable, independently of its relation to the crossing, and safety is in some cases impaired by the presence of such a light as interferes with a clear view by locomotive engineers. The cost of lights varies from $40.00 to $120.00 per annum.

When an electric railway line is crossed the consequences of an accident become very grave, but no well-settled usage or theory of protection appears to have been established. State laws do not as yet take account of this case, except in a desultory way, through the control exercised by the State Railroad Commissioners; and widely varying opinions have been received from those answering the Committee's circular as to the proper regulation of the use of the crossing; many recognizing no obligation on the steam railway to use more care than in the case of an ordinary crossing, and some going so far as to advocate the same precautions as when crossing the tracks of another steam railway.

The most common practice is to depend on the street-car conductor to safely flag his car over the crossing, presupposing a higher degree of discipline than either his training or ordinary duties tend to promote.

The conditions surrounding the use of crossings of electric lines change materially from the case of the interurban line operated along a country highway and often at a rather high speed, to that of the city street-car line protected by gates and watchmen and requiring only to take account of steam trains which are being moved under control. The means adopted to avert accident can therefore be modified to suit the re-

quirements of the case, but it is desirable that the steam railroad companies should, while asserting their superior claim to the use of the crossing, accept some responsibility and demand such protection as will insure safety.

In all cases where the steam railway train may approach the crossing at high speed, or where the grade of the street railway tracks does not admit of controlling cars under all conditions, there should be more safeguards than the vigilance and judgment of the street-car conductor.

The tendency of advanced practice is to require derails in the street-car tracks, located at a proper distance and worked by a lever on the opposite side of the crossing. The lever should be interlocked with signals on the steam railway track, or, preferably, with a track circuit block, so as to close the crossing to electric cars when the steam railway track is occupied, the levers being worked by the conductor of the electric car. The latter plan is safer, and the occasional short delays to electric car movements are fully offset by the avoidance of delays to important trains and by not requiring additional signals. This plan affords the degree of safety which, in the opinion of the Committee, is necessary in most cases when gates and watchmen are not provided.

The question of how much a railroad company can afford to pay to avoid a grade crossing can only be settled by the consideration of special cases. It involves the financial ability of the railroad, the expense of maintenance, the unknown element of risk, and various other conditions which are sometimes equally important.

The actual cost of constructing and maintaining a single track grade crossing with cattle-guards, etc., may be capitalized at about $300, or, if alarm bells are added, about $700. At most crossings in sparsely settled districts the average risk is indefinite, but certainly small. The Northern Pacific Railroad reports 102 accidents for two years, all at stations, and 26 of them on branch lines. The sum charged for claims arising from these road-crossing accidents outside of cities, when capitalized at 5 per cent., amounts to $119.20 per crossing. The claims for crossing accidents on the Kansas City, Fort Scott & Memphis and Kansas City, Memphis & Birmingham main line and branches may be fairly capitalized at $50 per crossing.

The crossing accidents in New York in 1899, reported by the State Railroad Commission, amount to 101 deaths and 79 injuries, resulting from operation of about 8,000 miles of line. A large proportion of these probably occurred at city crossings and probably very few at country crossings remote from stations. The Committee's information on the subject is meagre, but seems to justify the conclusion that a very small sum will, in average cases, cover the item of risk at country crossings, so that most roads would doubtless be willing to exceed their real financial interest in aiding to eliminate them.

When the maintenance of the expensive accessories of important city crossings is capitalized the amount becomes large, and more than railroad companies would be willing to pay to avoid the operating expense alone.

In these cases, however, the risk becomes great, and city regulations affect the cost and convenience of handling business, so that special and important problems are presented which cannot be briefly generalized, but which, in connection with the subject of the separation of grades, the Committee hopes to consider in a future report.

D. Bontecou, Kansas City, Ft. Scott & Memphis, Kansas City, *Chairman;*
C. A. Wilson, Cincinnati, Hamilton & Dayton Railway, Cincinnati, *Vice-Chairman;*
G. F. Bidwell, Fremont, Elkhorn & M. V., Omaha;
J. R. W. Davis, Erie Railroad, Jersey City;
H. J. Slifer, Chicago & Northwestern Railway, Boone, Ia.;
W. Shepard, Chief Engineer Boston & Albany, Boston, Mass.;
R. Southgate, Southern Railway, Salisbury, N. C.;
Committee.

Mr. D. Bontecou:—This Committee was unfortunate enough to lose its original chairman, and for that reason the Committee was very much delayed in its efficient organization, and this result may hardly be said to be accomplished yet. The Committee thought it was best, in view of the limitations on its work to confine its attention to the subject which seemed to logically introduce the topics assigned to the Committee—that of the safety of highway crossings or protection of surface crossings. And it has endeavored, so far as it was able from the information in its possession, to entirely cover that subject, with possibly the exception of cattle-guards. I will say that the report is accepted by the Committee as a whole, with the exception of one member, who is lost. There are so many legal restrictions in connection with this subject that it was thought desirable to make a compilation of the state laws—the statutory regulations affecting crossings, which we have supposed would be of use to some. In so far as the matter in the report is concerned, from such information as we had, it appeared to be the case that there was great uniformity of practice among different roads, and very few points indeed which might be considered mooted ones, about which very much difference of opinion exists. And for that reason I don't know that there is anything I care especially to call attention to in order to elicit special discussion. (See Appendix for State Laws.)

The President:—Any remarks on the report? It seems to be backed up with a good deal of legal authority, and for this reason I presume we ought not to criticise it too severely. The

laws printed in connection with the report as an appendix I think we will find very useful for reference, particularly those members connected with roads running through fourteen to sixteen different states.

We have one other committee to report, which I understand has no formal printed report to offer. It is the Committee on Buildings. Is Mr. Parkhurst, the chairman, present?

Mr. Parkhurst:—I may say that we can report some progress on our work, but have nothing to offer for discussion. It is in such an unsatisfactory shape that I will have to ask to have the Committee either continued, excused or allowed to stand for the present.

The President:—We have now finished our regular formal reports of standing committees. Is there any new business before the Association?

Mr. W. McNab (Grand Trunk):—In looking over the list of subdivisions of the main subjects that are under consideration by the Association, it will be noticed that there is no reference whatever to the problem of snow, in its relation to railroads, beyond the consideration of a snow fence. It seems to me that the question of dealing with this problem, being a part of the operation of a railroad, should come within the purview of this Association. There is a wide belt of latitude extending from ocean to ocean, and embracing every physical feature, rolling country, plains, cañons and mountain regions, in which the element of snow year after year forms a very large proportion of the operating expenses, and I think it would be well for the roads lying within that territory to see how they stand, not only as one to another in their methods of dealing with this problem, but also in regard to prospective improvements. It is a fact that it is not always the part of the country in which the snowfall is heaviest that its effects on the railroads are felt the worst, because there are regions where the snowfall is light but difficult to deal with on account of the particular atmospheric influence bearing on the problem, and the manner in which the snow packs along the flange and head of the rail. I know of an instance where on a division of a certain road no train ran over it for four days last week, and yet there was very little snow over the track. The methods adopted to prevent snow

accumulating might be made one subdivision and the methods adopted to clear away the snow might be made another; in other words, methods of prevention and methods of cure, and these main subdivisions would be capable of being further subdivided to meet every feature connected with the subject. I bring the matter up now in order, if the Association thinks well of it, the Board of Direction might be requested to appoint a special committee or otherwise to make some investigations. If it is not in the province of this Association to deal with the snow matter, I would ask under whose auspices it would come?

The President:—The Board of Direction will give that matter consideration. While we are waiting for the report of the tellers I desire to say a few words before bidding you good-bye in my official capacity.

While we have reason to congratulate ourselves upon the rapid progress that we have made and the results of our efforts, the Association has yet a great deal to do—not only as an Association, but its President and Secretary, its standing committees and its individual members. The President and Secretary can only express the wishes of the Board of Direction and of the Association and give effect to the execution of those wishes. Upon the Board of Direction devolves not only the business management of the Association, but under our Constitution the direction of its work. The Board of Direction should give more attention in the future than it has in the past two years to the committee work, to examining the reports of the committees, to instructing the chairmen of those committees as to the methods they should use and as to the form of their report and as to how the matter should be treated, and should act as what might be called a general committee and supervise the work of all the committees.

The different committees should have their work outlined along certain lines by the Board of Direction.

Thus far, while we have had satisfactory results, the reports of our committees, in a measure, have been more or less crude. Different committees have worked along different lines, and some of our committees have not given the importance to the essentials of the subjects assigned them which they should have done.

The work of the last two years has been entirely experimental. The members of the committees, the members of the Association themselves, the Board of Direction, and even the officers so far have not really known the extent to which this Association might grow, how it would take hold of its work, and how the managements of the roads would appreciate the work. We have been groping in the dark. We have now, however, reached that point where the Board of Direction should more fully outline the policy of our work and the manner in which that work should be carried on, and should give to the different committees definite instructions as to their work. Sooner or later, in order to accomplish results, the period of talk must end and the period of action begin, and in order to get the full benefit of our Association our committees, it seems to me, should work toward the end of concise and definite recommendations. Some of the committees are so constituted that it is not possible for them to consider all the subheads given them for consideration, and at our meetings they should confine their recommendations to one thing, taking up another subject later on, and should strive toward final, definite results. As Mr. Sullivan very properly remarked, our committees should act as a unit and not as individuals; our committees should also recognize the fact that their individual work in a committee should be toward the success of that committee and its reports. They should all be factors in the work of the committee.

In our general meetings members should avoid wasting the time of the Association with trivial remarks such as apply to minor personal experiences in connection with their work or with matters that do not bear on the essential matters reported on by the committees. The field we have to cover is so great that we should use every endeavor to avoid wasting a moment of the time in our discussions, and we should speak briefly and to the point.

We have among our members—we have them at this meeting—men well posted on the subjects under discussion who never say a word. This is partly due to the fact that the presiding officer is not personally acquainted with the fact of their knowledge of these subjects. The result is that the burden of the meeting has devolved upon very few men. It is hoped that

this state of affairs will not continue and that at the next meeting we will have a fuller expression of the opinion of the members and a more general participation by them in our discussions.

Again, the committee chairmen should see to it that a copy of their report is sent to the Secretary at least thirty days prior to the annual meeting, so that the reports can be printed and disseminated among the members, and the members will then be expected to take time and thoroughly digest the subjects and come here prepared to make their remarks concise and to the point, after having given the matter due consideration. There are many more things I could say, but I feel as though it would simply be a repetition of what has been said or something you already know. I have the welfare of this Association very much at heart, and when I sever my pleasant official connection with it I hope to occupy a seat on the floor at your meetings and help fight the battles of the Association from the other side of the rostrum. (Applause.)

The Secretary:—The result of the election is as follows:

President—Mr. G. W. Kittredge.

Second Vice-President—Mr. A. W. Sullivan.

Treasurer—Mr. W. S. Dawley.

Secretary—Mr. L. C. Fritch.

Two Directors for three years, Mr. J. Kruttschnitt and Mr. T. F. Whittelsey.

Following is the vote in detail:

PRESIDENT.

G. W. Kittredge	206
A. W. Sullivan	8
T. F. Whittelsey	3
J. F. Wallace	2
W. G. Berg	1
W. S. Dawley	1
J. Kruttschnitt	1
A. Torrey	1

SECOND VICE-PRESIDENT.

A. W. Sullivan	211
G. W. Kittredge	8
Hunter McDonald	2
F. H. McGuigan	1

TREASURER.

W. S. Dawley	221
T. L. Condron	1

SECRETARY.

L. C. Fritch	221

TWO DIRECTORS.

J. Kruttschnitt	221
T. F. Whittelsey	218
I. G. Rawn	2
D. D. Carothers	1
G. W. Kittredge	1
W. K. McFarlin	1
C. A. Wilson	1

The President:—I regret to say that Mr. Kittredge, our newly-elected President, is not here, being called home on important business. This is the last act of our meeting and a motion to adjourn is in order.

Mr. W. S. Dawley (Chicago & Eastern Illinois):—I move that the Association tender a hearty vote of thanks to Mr. Wallace for his able and untiring efforts in the direction of the affairs of the Association during the term of his presidency.

Mr. A. W. Sullivan (Illinois Central):—In rising to second the motion, I desire to say that this Association owes Mr. Wallace a debt of gratitude for his arduous work in the upbuilding of the Association. If the satisfaction that one can derive in considering the success of his work is a reward, he will undoubtedly be satisfied with the consciousness that he has done his very best in behalf of this Association. In this connection I want to say, from my own point of view, as a chairman of one of the committees, that I think the impetus which has been given by Mr. Wallace and his associates on the Board of Direction to the affairs of this Association is in exactly the right direction to develop the best results, and we are under great obligations to them for their wisdom and their energy in putting this Association so quickly in such an advanced state of development. (Great applause.)

The President:—No one on this rostrum is in a position to put the question on that motion. We know things that you do not—we know how much we have neglected.

The motion was unanimously adopted.

Mr. A. R. Raymer (Pittsburg & Lake Erie) :—I move that the Secretary be instructed to tender the thanks of the Association to the Illinois Central Railroad Company for the use of the special train to the South Chicago mills.

The motion was seconded and unanimously adopted.

Mr. McNab:—I would like to move that the acknowledgments of this Association be tendered the Technical Club of Chicago for the courtesies which they have placed at our disposal while the Association has been in session here.

The motion was seconded and unanimously adopted.

On motion, the meeting adjourned sine die.

APPENDIX

OFFICERS FOR 1901.

PRESIDENT.

G. W. KITTREDGE, Cleveland, Cincinnati, Chicago & St. Louis Railway, Cincinnati, Ohio.

FIRST VICE-PRESIDENT—ONE YEAR.

HUNTER McDONALD, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

SECOND VICE-PRESIDENT—TWO YEARS.

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DIRECTORS.

Three Years.

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T. F. WHITTELSEY, Toledo & Ohio Central Railway, Toledo, O.

Two Years.

A. TORREY, Michigan Central Railroad, Detroit, Mich.
THOS. RODD, Pennsylvania Lines West of Pittsburg, Pittsburg, Pa.

One Year.

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H. F. BALDWIN, Chicago & Alton Railway, Chicago, Ill.

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176. ADDISON, C. L.,
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237. AISHTON, R. H.,
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129. ATWOOD, J. A.,
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382. Baldwin, L. W.,
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323. Barnard, J. A.,
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121. Barrington, Edward,
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119. Bates, Onward,
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275. Beauman, L.,
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239. Bell, Robert,
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213. Bent, Sheldon T.,
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179. Berry, J. B.,
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223. Bidwell, Geo. F.,
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227. Bissell, F. E.,
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375. Norton, A. G.,
Acting Division Engineer Baltimore & Ohio Southwestern Railroad, Flora, Ill.

231. Norton, Charles T.,
Superintendent Road Department Mexican International Railway, Ciudad Porfirio Diaz, Mexico.

285. NAUGLE, J. A.,
Assistant General Manager New Mexico & Arizona Railroad and Sonora Railway, Guaymas, Sonora, Mexico.

O

204. OBORNE, JAMES,
General Superintendent Atlantic Division Canadian Pacific Railway, St. John, N. B.

P

190. PALMER, W. S.,
Resident Engineer Southern Pacific Company, Oakland, Cal.

208. PAQUETTE, C. A.,
Superintendent Cleveland, Cincinnati, Chicago & St. Louis Railway, Indianapolis, Ind.

68. PARADIS, F. E.,
Chief Engineer Chicago Terminal Transfer Railroad, Grand Central Passenger Station, Chicago, Ill.

307. PARET, M. P.,
Chief Engineer Kansas City, Mexico & Orient Railway, Seventh and Wyandotte Streets, Kansas City, Mo.

212. PARKHURST, H. W.,
Engineer Bridges and Buildings Illinois Central Railroad, Chicago, Ill.

180. PATTERSON, F. M.,
Roadmaster Chicago, Burlington & Kansas City Railway, Moulton, Iowa.

147. PEDDLE, W. H.,
General Superintendent of Transportation Southern Railway, 1300 Pennsylvania Avenue, Washington, D. C.

262. PENCE, W. D.,
Professor of Civil Engineering Purdue University, Lafayette, Ind.

293. PENNINGTON, E.,
General Manager Minneapolis, St. Paul & Sault Ste. Marie Railway, Minneapolis, Minn.

7. PETERSON, P. ALEX.,
Chief Engineer Canadian Pacific Railway, Montreal, Canada.

38. PFAFFLIN, E. H.,
Chief Engineer Evansville & Terre Haute Railroad, Evansville, Ind.

263. PHILBRICK, ALVAH,
Superintendent Illinois Central Railroad,
Memphis, Tenn.

302. PHILLIPS, H. C.,
Resident Engineer Atchison, Topeka & Santa Fe Railway,
Ottawa, Kas.

33. PIERCE, H.,
Engineer Maintenance-of-Way Chesapeake & Ohio Railway,
Huntington, W. Va.

234. POLAND, WILLIAM B.,
Division Engineer Baltimore & Ohio Southwestern Railroad, Washington, Ind.

283. PROUT, H. G.,
Chief Editor Railroad Gazette,
32 Park Place, New York, N. Y.

348. PUGH, STANLEY D.,
Assistant Engineer Columbus, Sandusky & Hocking Railway, Columbus, Ohio.

210. PURCELL, THOMAS,
Division Superintendent Mexican National Railroad,
Matamoros, Mexico.

Q

193. QUINLAN, G. A.,
Vice-President and General Manager Houston & Texas Central Railroad, Houston, Texas.

R

230. RAWN, I. G.,
General Superintendent Baltimore & Ohio Southwestern Railroad, Cincinnati, Ohio.

311. RANDALL, E. J.,
Engineer Maintenance-of-Way Toledo, St. Louis & Western Railroad, Frankfort, Ind.

126. RAYMER, A. R.,
Assistant Chief Engineer Pittsburg & Lake Erie Railroad,
Pittsburg, Pa.

342. RICE, F. C.,
Superintendent Illinois Lines Chicago, Burlington & Quincy Railroad, Galesburg, Ill.

117. RICHARDS, J. T.,
Engineer Maintenance-of-Way Pennsylvania Railroad,
Philadelphia, Pa.

63. RICHARDS, O. D.,
Chief Engineer Ann Arbor Railroad,
Toledo, Ohio.

356. ROBINSON, A. A.,
President Mexican Central Railway,
Boston, Mass.

363. ROBINSON, A. F.,
Bridge Engineer Atchison, Topeka & Santa Fe Railway System, Topeka, Kas.

48. ROBINSON, H. P.,
Editor Railway Age,
Chicago, Ill.

137. ROBINSON, J. B.,
Resident Engineer Southern Pacific Company,
Sacramento, Cal.

226. ROCKWELL, SAMUEL,
Principal Assistant Engineer Lake Shore & Michigan Southern Railway, Cleveland, Ohio.

4. RODD, THOMAS (Director),
Chief Engineer Pennsylvania Lines West,
Pittsburg, Pa.

265. RODGERS, J. G.,
Superintendent New York, Philadelphia & Norfolk Railroad,
Cape Charles, Va.

346. ROGERS, E. I.,
Assistant Engineer Illinois Central Railroad,
Memphis, Tenn.

264. ROGERS, M. H.,
Chief Engineer Denver & Rio Grande Railroad,
Denver, Colo.

222. ROHWER, H.,
Chief Engineer Missouri-Pacific Railway,
St. Louis, Mo.

360. ROTE, R. O.,
Second Assistant Engineer Lake Shore & Michigan Southern Railway, Cleveland, Ohio.

355. RUDD, A. H.,
Signal Engineer Delaware, Lackawanna & Western Railroad, Hoboken, N. J.

S

125. SABIN, A. T.,
Assistant Engineer Illinois Central Railroad,
Fulton, Ky.

266. SAFFORD, H. R.,
Roadmaster Illinois Central Railroad,
Clinton, Ill.

377. SANDS, G. L.,
Vice-President and General Manager St. Louis, Kansas City & Colorado Railroad, St. Louis, Mo.

186. SANFORD, A. H.,
Engineer Maintenance-of-Way Pennsylvania Lines West,
Allegheny, Pa.

138. SCARBOROUGH, F. W.,
Engineer Bridges and Signals Chesapeake & Ohio Railway,
Richmond, Va.

143. SCHINDLER, A. D.,
Superintendent San Francisco & San Joaquin Valley Railroad,
Stockton, Cal.

308. SCHNEIDER, C. C.,
Vice-President American Bridge Company,
100 Broadway, New York, N. Y

386. SESSER, J. C.,
Resident Engineer Chicago, Milwaukee & St. Paul Railway,
Old Colony Building, Chicago, Ill.

336. SHAW, A. M.,
Roadmaster Illinois Central Railroad,
Mattoon, Ill.

95. SHAW, LOUIS,
Civil Engineer,
La Crosse, Wis.

268. SHEAHAN, DENNIS,
Roadmaster Illinois Central Railroad,
Memphis, Tenn.

75. SHELAH, EDWARD,
Supervisor Philadelphia & Reading Railway,
Philadelphia, Pa.

162. SHEPARD, W.,
Chief Engineer Boston & Albany Railroad,
Boston, Mass.

85. SIMS, C. S.,
Engineer Maintenance-of-Way Pennsylvania Lines West,
Chicago, Ill.

21. SLIFER, H. J.,
Superintendent Chicago & Northwestern Railway,
Boone, Iowa.

61. SLOAN, DAVID,
Chief Engineer of Construction Illinois Central Railroad,
Chicago, Ill.

335. SNOW, J. P.,
Bridge Engineer Boston & Maine Railroad,
Boston, Mass.

277. SOUTHGATE, R.,
Engineer Maintenance-of-Way Southern Railway,
Salisbury, N. C.

120. SROUFE, C. C.,
Resident Engineer Southern Pacific Company,
Tucson, Ariz.

345. STEELE, HENRY M.,
Chief Engineer Central of Georgia Railway,
Savannah, Ga.

24. STEVENS, F. S.,
Superintendent Philadelphia & Reading Railway,
Reading, Pa.

352. STEVENS, T. S.,
Signal Engineer Atchison, Topeka & Santa Fe Railway,
Topeka, Kas.

304. STIMSON, F. C.,
Assistant Engineer Chicago & Northwestern Railway,
West Grand Rapids, Wis.

371. STITES, A. C.,
Resident Engineer Phœnix Bridge Company,
The Rookery, Chicago, Ill.

74. STOREY, W. B., JR.,
Chief Engineer Atchison, Topeka & Santa Fe Railway,
Topeka, Kas.

98. SULLIVAN, A. W. (Second Vice-President),
Assistant Second Vice-President Illinois Central Railroad,
Chicago, Ill.

315. SWAIN, G. F.,
Professor of Civil Engineering Massachusetts Institute of Technology; Engineer Massachusetts Railroad Commission; Member Boston Transit Commission,
Boston, Mass.

130. SWAINE, E. L.,
Resident Engineer Southern Pacific Company,
Los Angeles, Cal.

347. SWANITZ, A. W.,
Chief Engineer Chicago Transfer & Clearing Company,
355 Dearborn Street, Chicago, Ill.

T

159. TAIT, THOMAS,
Manager Eastern Lines Canadian Pacific Railway,
Montreal, Canada.

299. TAYLOR, J. G.,
Assistant Engineer St. Louis & San Francisco Railroad,
Peirce City, Mo.

269. TAYLOR, J. W.,
Chief Engineer Terminal Railroad Association,
St. Louis, Mo.

111. THOMAS, J. W., JR.,
General Manager Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

290. THOMPSON, W. S.,
Assistant Engineer Chautauqua Division Pennsylvania Railroad, Oil City, Pa.

1. TORREY, A. (Director),
Chief Engineer Michigan Central Railroad, Detroit, Mich.

215. TRATMAN, E. E. RUSSELL,
Resident Editor Engineering News, Monadnock Block, Chicago, Ill.

320. TRAVIS, O. J.,
Superintendent of Bridges Illinois Central Railroad, 106 Seventy-sixth Street, Chicago, Ill.

67. TRIMBLE, ROBERT,
Principal Assistant Engineer Pennsylvania Lines West. Pittsburg, Pa.

372. TRUEMAN, HARMON,
Chief Engineer Morden Frog & Crossing Works, The Rookery, Chicago, Ill.

359. TURK, J. E.,
Division Engineer Philadelphia & Reading Railway, Reading, Pa.

379. TUTHILL, JOB,
Bridge Engineer Pere Marquette Railroad, Detroit, Mich.

112. TWEEDY, R. B.,
Chief Engineer Wisconsin Central Lines, Milwaukee, Wis.

364. TYE, W. F.,
Chief Engineer of Construction Canadian Pacific Railway, Montreal, Canada.

U

155. UNDERWOOD, F. D.,
President Erie Railroad, New York, N. Y.

V

195. VAN VLECK, W. G.,
General Manager Atlantic System Southern Pacific Company, Houston, Texas.

103. VAUGHAN, G. W.,
Division Engineer New York Central & Hudson River Railroad, Jersey Shore, Pa.

158. VAUGHN, G. W.,
Engineer in Charge of Track Elevation A., T. & S. F., C., M. & N., and C. & A. Railways, 2476 Archer Avenue, Chicago, Ill.

W

3. WALLACE, J. F. (Past-President),
Assistant General Manager Illinois Central Railroad, Chicago, Ill.

57. WALLACE, H. U.,
Superintendent Illinois Central Railroad, Louisville, Ky.

76. WALLACE, J. H.,
Engineer Maintenance-of-Way Pacific System Southern Pacific Company, San Francisco, Cal.

122. WALKER, I. O.,
Assistant Engineer Nashville, Chattanooga & St. Louis Railway, Paducah, Ky.

349. WASHBURN, E. C.,
General Manager Bismarck, Washburn & Great Falls Railway, Bismarck, N. D.

188. WASHINGTON, L. A.,
Assistant Engineer Illinois Central Railroad, Paducah, Ky.

354. WATSON, THOS.,
Resident Engineer Western Railways of Australia, Geraldton, Western Australia.

37. WEBSTER, G. H.,
Resident Engineer Canadian Pacific Railway, Winnipeg, Man.

306. WEBSTER, WM. R.,
Consulting and Inspecting Engineer, 411 Walnut Street, Philadelphia, Pa.

127. WENDT, E. F.,
Assistant Engineer Pittsburg & Lake Erie Railroad, Pittsburg, Pa.

69. WHEATON, L. H.,
Superintendent and Chief Engineer Halifax & Yarmouth Railway, Yarmouth, N. S.

228. WHITE, H. F.,
Chief Engineer Burlington, Cedar Rapids & Northern Railway, Cedar Rapids, Iowa.

66. WHITE, I. F.,
Superintendent Track and Structures Cincinnati, Hamilton & Dayton Railway, Hamilton, O.

92. WHITTELSEY, T. F. (Director),
General Superintendent Toledo & Ohio Central Railway, Toledo, O.

60. WHITTEMORE, D. J.,
Chief Engineer Chicago, Milwaukee & St. Paul Railway, Chicago, Ill.

14. WICKHAM, C. E.,
General Roadmaster Chicago, Rock Island & Pacific Railway, Davenport, Iowa.

185. WILGUS, W. J.,
Chief Engineer New York Central & Hudson River Railroad, New York, N. Y.

104. WILLARD, DANIEL,
Assistant to President Erie Railroad,
New York, N. Y.

271. WILLIAMS, H. R.,
General Manager Chicago, Milwaukee & St. Paul Railway, Chicago, Ill.

32. WILLIAMS, W. D.,
Chief Engineer Cincinnati Northern Railroad,
Van Wert, Ohio.

9. WILSON, C. A.,
Chief Engineer Cincinnati, Hamilton & Dayton Railway, Cincinnati, O.

270. WILSON, J. T.,
Chief Engineer Pittsburg, Connellsville & Wheeling Railroad, Moundsville, W. Va.

278. WOODS, H. A.,
Assistant Engineer Chicago & Grand Trunk Railway, Detroit, Mich.

101. WOODWARD, E. K.,
Engineer Maintenance-of-Way Wabash Railroad, Detroit, Mich.

202. WOODWARD, ROLAND,
Chief Engineer Jacksonville & Southwestern Railroad, Jacksonville, Fla.

200. WOODWORTH, G. B.,
Rail Inspector Chicago, Milwaukee & St. Paul Railway, Chicago, Ill.

Z

207. ZIESING, A.,
Western Manager American Bridge Company, Monadnock Block, Chicago, Ill.

DECEASED MEMBERS.

BURKE, S. E.
CAFFREY, RICHARD.
CARPENTER, C. A.
CASEY, D. J.
CLARKE, L. H.
CURTIS, W. G.
HALL, FERD.
O'MELVENY, J. C.
SCHMIDT, H. W.

In Memoriam

WILLIAM GIDDINGS CURTIS,

Second Vice-President of the Association.

William Giddings Curtis was born at Bridgeport, Conn., August 19, 1849. He moved with his family from Connecticut to San Diego County, California, in 1864. Entered railway service in 1865, since which he was consecutively: 1865-1870 in Engineering Department Central Pacific Railroad; 1870-1872, Resident Engineer on Construction San Joaquin Valley Railroad; 1872-1881, Assistant and Division Superintendent, California and Arizona and New Mexico roads, operated by the Central Pacific Railroad; 1882-1890, Superintendent of Track, Central Pacific Railroad and Pacific System, Southern Pacific Company; also, 1888-1895, Assistant to General Manager, Pacific System and Lines in Oregon, Southern Pacific Company; 1890-1900, Engineer Maintenance-of-Way, Pacific System and Lines in Oregon, Southern Pacific Company.

Mr. Curtis was married on June 15, 1875, at Stockton, Cal., to Miss Mary Elizabeth Burton. Died at Highland Springs, Cal., June 15, 1900.

Mr. Curtis was descended from a long line of distinguished citizens of Connecticut. His family history can be traced back in unbroken succession in that state to 1632, in which year the original settler, William Curtis, came to New England in the ship "Lion" from Essex County, England. Many of the family were Revolutionary soldiers, during the War of Independence with Great Britain.

Mr. Curtis' accomplishments were so many and his knowledge so thorough in so many different branches that it is extremely difficult to pick out any one particular line in which he excelled more than in another.

His memory was marvelous, not only in range, but in accuracy; his industry untiring; he was a man of the highest sense of honor. In his intercourse with his associates, subordinates and others, he was always frank, straightforward and manly, courteous and genial; even-tempered often under the most trying circumstances.

What perhaps to railroad men was his most striking and interesting trait of character, was his intense loyalty to the corporation he served, and whose interests he so largely controlled. He spared neither labor nor time, and shunned neither personal inconvenience nor discomfort in advancing the interests of his company, and such was the strength of his character and the force of his example, that he impressed this sentiment of loyalty upon the entire service.

While it is customary in these cases to review the important works performed by the subject of the sketch, it would be difficult, if not impossible, to give any adequate idea of Mr. Curtis' life-work without a nearly complete description of the physical properties of the Pacific System and lines in Oregon of the Southern Pacific Company, with its many miles of track, bridges and structures, embracing a wide range and covering the most varying conditions—his work is his best eulogy.

He was a convincing writer on technical subjects, and his writings show the close, logical thought so characteristic of the man.

As to social characteristics, Mr. Curtis was a graceful and fluent speaker; thoughts and expression came very readily to him; he never failed by well-chosen words and apt illustrations to impress upon his audience the points he desired to make.

In the death of Mr. Curtis, his company, his friends and his associates have met with an irreparable loss.

JOHN D. ISAACS.

In Memoriam

WILLIAM GIDDINGS CURTIS.

Dwight, Ill., March 2, 1901.

Mr. J. F. Wallace,
President of the American Railway Engineering and Maintenance-of-Way Association,
Chicago, Ill.

My Dear Sir:—'Though not a member of your society, I feel a strong desire to say a word to you in commemoration of the late W. G. Curtis, Second Vice-President of your Association.

My first professional meeting with Mr. Curtis was at Ogden, Utah, in 1887. He then represented the Central and Southern Pacific companies. During my critical examination of those systems for the government, occupying about two months' time, Mr. Curtis accompanied me and furnished verbal and printed data for my verification.

Loyal in a marked degree to the interests he represented, I nevertheless came in a few days to respect him most highly as a gentleman and fair-minded engineer. 'Though considerably his senior, I was drawn to him in friendship as he manifested to me his goodness of heart, firm integrity of character, and also his professional skill and personal worth.

In the discharge of my duties with him on that and other similar occasions to the end of his life, I closely observed his works as a civil engineer, and his wise and efficient care of the great properties which were entrustd to him.

'Though so young, comparatively, his was a long and very active and useful professional career.

I may be permitted to say to you, comparing him with other civil engineers of national reputation, that he was the peer in admirable professional ability and personal excellence of any other engineer it has been my privilege to know. You, of course, are aware of the high hopes which animated him at the last annual meeting of your society, and how heartily he entered into the work of promoting the welfare of your Association.

His death in his prime of usefulness will be deeply felt by all who knew him.

Very sincerely yours,

RICHARD PRICE MORGAN.

In Memoriam

SHERMAN EMMET BURKE,

Engineer Maintenance-of-Way, Cleveland, Akron & Columbus Railway.
Died October 17, 1900; Age 28 Years 8 Months.

Mr. Burke was born at Cincinnati, Ohio, February 17, 1872, was educated at the Ohio State University, Columbus, Ohio, from which institution he was graduated in 1892.

In June, 1894, he first entered railroad service as assistant on engineer corps of the Cincinnati, Portsmouth & Virginia Railway, at Cincinnati, Ohio, which position he left in March of the following year, 1895, to accept a similar one with the Cincinnati, Lebanon & Northern Railway, which road is one of the divisions of the Pennsylvania Lines west of Pittsburg. In June, 1895, he left the Maintenance-of-Way department and entered that of the Chief Engineer of the Pennsylvania Lines, being assigned to duty on the Newport & Cincinnati Bridge, then under course of reconstruction. Until July, 1897, he performed various duties under the direction of the Chief Engineer, at which time he again entered the Maintenance-of-Way department as Assistant Engineer of the Richmond division of the Pennsylvania Lines, with office at Richmond, Ind. On July 1, 1899, he was transferred to the Cleveland, Akron & Columbus Railway (which was absorbed about that time by the Pennsylvania Lines), as Assistant Engineer, and November 1, 1899, was appointed Engineer Maintenance-of-Way of that road, which position he occupied at the time of his death, October 17, 1900.

Mr. Burke was a man of more than the average natural ability to which he had added a thorough technical education. He was energetic, tirelessly so, never sparing himself but performing every duty with utter disregard of his personal convenience and comfort and exacting similar service from his assistants, the result of this being that, although only a short time in the railroad service he had already begun to make his personality felt. In his death his company has lost an honest and efficient servant, his associates a true and lasting friend.

In Memoriam

LEVERETT H. CLARKE.

Leverett H. Clarke was born in Becket, Mass., March 9, 1830, and received his education at the common schools of that place, afterward graduating from Lee Academy. He began work on the Illinois Central road in 1849, and was promoted from time to time until he was made Chief Engineer in 1859, which position he held until 1877. He was Chief Engineer of the L. S. & M. S. Ry. from 1877 to 1887; had charge of the location and construction of the Pacific Short Line, from Sioux City, Iowa, to O'Neill, Neb., about 1890, and was afterward City Engineer of Chicago for two years. His last active work was the elevating of the tracks of the L. S. & M. S. Ry. and C., R. I. & P. Ry. between Archer Avenue and Englewood, 1894 to 1898 inclusive. He died March 20, 1900.

Mr. Clarke was an engineer of undoubted ability and his death is a great loss to this Society, as his long experience in engineering matters would have made his advice and counsel extremely valuable.

E. A. HANDY.

STATEMENT SHOWING THE MEMBERSHIP AND MILEAGE OF THE ROADS REPRESENTED IN THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION.

Name of Road and Membership.	Mileage.	No. of Members.
Algoma Central Railway	120	2
F. D. Anthony, Sault Ste. Marie, Ont.		
Geo. Crocker, Sault Ste. Marie, Ont.		
Ann Arbor Railroad	292	2
O. D. Richards, Toledo, O.		
G. W. Gardner, Cadillac, Mich.		
Arizona & New Mexico Railroad	71	1
H. M. McCartney, Kingman, Ariz.		
Atchison, Topeka & Santa Fe Railway System	7,807	7
James Dun, Chicago, Ill.		
J. G. Hartigan, Chicago, Ill.		
G. W. Vaughn, Chicago, Ill.		
W. B. Storey, Jr., Topeka, Kas.		
A. F. Robinson, Topeka, Kas.		
T. S. Stevens, Topeka, Kas.		
H. C. Phillips, Ottawa, Kas.		
Baltimore & Ohio Railroad	2,278	3
W. T. Manning, Baltimore, Md.		
C. Lewis, Baltimore, Md.		
T. J. Frazier, Zanesville, O.		
Baltimore & Ohio Southwestern Railroad	921	7
I. G. Rawn, Cincinnati, O.		
D. D. Carothers, Cincinnati, O.		
Wm. Archer, Cincinnati, O.		
L. C. Fritch, Washington, Ind.		
W. B. Poland, Washington, Ind.		
J. G. Bloom, Chillicothe, O.		
A. G. Norton, Flora, Ill.		
Bismarck, Washburn & Great Falls Railroad	46	2
E. C. Washburn, Bismarck, N. D.		
J. M. Dixon, Bismarck, N. D.		

Name of Road and Membership.	Mileage.	No. of Members.
Boise, Nampa & Owyhee Railway	81	2
J. M. Clark, Nampa, Idaho.		
E. C. Macy, Nampa, Idaho.		
Boston & Albany Railroad	394	1
Walter Shepard, Boston, Mass.		
Boston & Maine Railroad	2,308	1
J. P. Snow, Boston, Mass.		
Buffalo & Susquehanna Railroad	157	2
H. Herden, Galeton, Pa.		
H. C. Landon, Austin, Pa.		
Buffalo, Attica & Arcade Railway	28	1
S. S. Bullis, Olean, N. Y.		
Buffalo, Rochester & Pittsburg Railway	472	1
J. M. Floesch, Rochester, N. Y.		
Burlington, Cedar Rapids & Northern Railway	1,284	2
H. F. White, Cedar Rapids, Ia.		
Garrett Davis, Cedar Rapids, Ia.		
Burlington's Missouri Line	1,067	3
Howard Elliott, St. Louis, Mo.		
L. F. Goodale, St. Joseph, Mo.		
F. M. Patterson, Moulton, Ia.		
Canada Atlantic Railway	466	1
G. A. Mountain, Ottawa, Canada.		
Canadian Pacific Railway	8,324	8
Thos. Tait, Montreal, Canada.		
P. Alex. Peterson, Montreal, Canada.		
W. F. Tye, Montreal, Canada.		
D. MacPherson, Montreal, Canada.		
J. W. Leonard, Winnipeg, Man.		
G. H. Webster, Winnipeg, Man.		
A. L. Buck, Winnipeg, Man.		
James Oborne, St. John, N. B.		
Central New England Railroad	181	1
C. H. Ewing, Hartford, Conn.		

Name of Road and Membership.	Mileage.	No. of Members.
Central of Georgia Railway	1,607	2
Theo. D. Kline, Savannah, Ga.		
Henry M. Steele, Savannah, Ga.		
Central Vermont Railway	513	2
E. H. Fitzhugh, St. Albans, Vt.		
Jos. Morrison, St. Albans, Vt.		
Chesapeake & Ohio Railway	1,285	2
F. W. Scarborough, Richmond, Va.		
H. Pierce, Huntington, W. Va.		
Chicago Great Western Railway	1,023	1
F. R. Coates, St. Paul, Minn.		
Chicago Transfer & Clearing Company		1
A. W. Swanitz, Chicago, Ill.		
Chicago & Alton Railway	900	4
S. M. Felton, Chicago, Ill.		
H. F. Baldwin, Chicago, Ill.		
J. R. W. Davis, Bloomington, Ill.		
F. C. Miller, Springfield, Ill.		
Chicago & Eastern Illinois Railroad	725	3
M. J. Carpenter, Chicago, Ill.		
W. S. Dawley, Chicago, Ill.		
A. S. Markley, Danville, Ill.		
Chicago & Northwestern Railway	5,585	5
W. A. Gardner, Chicago, Ill.		
R. H. Aishton, Chicago, Ill.		
H. J. Slifer, Boone, Ia.		
F. C. Stimson, West Grand Rapids, Wis.		
E. A. Kellogg, Boone, Iowa.		
Chicago & Western Indiana Railway	48	1
E. H. Lee, Chicago, Ill.		
Chicago, Burlington & Quincy Railroad	2,643	3
F. A. Delano, Chicago, Ill.		
W. L. Breckinridge, Chicago, Ill.		
F. C. Rice, Galesburg, Ill.		
Chicago Junction Railway	25	1
J. B. Cox, Chicago, Ill.		

Name of Road and Membership.	Mileage.	No. of Members.
Chicago, Milwaukee & St. Paul Railway	6,592	5
H. R. Williams, Chicago, Ill.		
D. J. Whittemore, Chicago, Ill.		
J. B. Moll, Chicago, Ill.		
G. B. Woodworth, Chicago, Ill.		
J. C. Sesser, Chicago, Ill.		
Chicago, Peoria & St. Louis Railway	300	1
Curtis Millard, Springfield, Ill.		
Chicago, Rock Island & Pacific Railway	3,827	4
W. E. Dauchy, Chicago, Ill.		
R. W. Day, Chicago, Ill.		
W. H. Davisson, Topeka, Kas.		
C. E. Wickham, Davenport, Ia.		
Chicago Terminal Transfer Railroad	107	4
J. N. Faithorn, Chicago, Ill.		
F. E. Paradis, Chicago, Ill.		
E. R. Knowlton, Chicago, Ill.		
J. A. Lahey, Chicago, Ill.		
Choctaw, Oklahoma & Gulf Railroad	659	1
F. A. Molitor, Little Rock, Ark.		
Cincinnati, Hamilton & Dayton Railway	652	2
C. A. Wilson, Cincinnati, O.		
I. F. White, Hamilton, O.		
Cincinnati Northern Railroad	402	2
J. B. Flanders, Toledo, O.		
W. D. Williams, Van Wert, O.		
Cleveland, Cincinnati, Chicago & St. Louis Railway	2,287	4
G. W. Kittredge, Cincinnati, O.		
Hadley Baldwin, Indianapolis, Ind.		
C. A. Paquette, Indianapolis, Ind.		
W. S. Moore, Galion, O.		
Cleveland, Lorain & Wheeling Railway	192	2
W. B. Hanlon, Cleveland, O.		
J. H. Abbott, Uhrichsville, O.		
Colorado & Southern Railroad	1,142	1
H. W. Cowan, Denver, Colo.		

Name of Road and Membership.	Mileage.	No. of Members.
Columbus, Sandusky & Hocking Railway S. D. Pugh, Columbus, O.	270	1
Columbia & Southern Railroad A. E. Hammond, Shaniko, Ore.	76	1
Delaware, Lackawanna & Western Railroad W. K. McFarlin, Hoboken, N. J. C. S. Millard, Hoboken, N. J. A. H. Rudd, Hoboken, N. J.	951	3
Delaware, Susquehanna & Schuylkill Railroad Edgar Kudlich, Drifton, Pa.	45	1
Denver & Rio Grande Railroad M. H. Rogers, Denver, Colo. J. C. Hechler, Pueblo, Colo.	1,675	2
Duluth & Iron Range Railroad W. A. McGonagle, Duluth, Minn.	161	1
Erie Railroad F. D. Underwood, New York, N. Y. Daniel Willard, New York, N. Y.	2,182	2
Esquimalt & Nanaimo Railway Jos. Hunter, Victoria, B. C.	82	1
Evansville & Terre Haute Railway E. H. Pfafflin, Terre Haute, Ind.	167	1
Federal District Railway of Mexico H. P. Bradford, City of Mexico.	220	1
Florence & Cripple Creek Railroad J. J. Frey, Denver, Colo.	54	1
Fort Worth & Denver City Railroad J. V. Goode, Fort Worth, Texas.	43	1
Fremont, Elkhorn & Missouri Valley Railroad G. F. Bidwell, Omaha, Neb.	1,301	1
Fulton County Railroad S. H. Mallory, Chariton, Ia.	61	1

Name of Road and Membership.	Mileage.	No. of Members.
Grand Trunk Railway	4,179	4
F. H. McGuigan, Montreal, Canada.		
W. McNab, Montreal, Canada.		
M. S. Blaiklock, Montreal, Canada.		
H. A. Woods, Detroit, Mich.		
Great Northern Railway	6,417	2
J. D. Mason, St. Paul, Minn.		
H. A. Kennedy, Kalispell, Mont.		
Guatemala Central Railway	113	1
D. B. Hodgsdon, Guatemala City, Guatemala, C. A.		
Gulf & Ship Island Railway	250	1
J. B. Hatch, Gulfport, Miss.		
Gulf, Colorado & Santa Fe Railway	1,128	3
C. F. W. Felt, Galveston, Texas.		
L. Beauman, Cleburne, Texas.		
J. C. Christy, Milano Junction, Texas.		
Halifax & Yarmouth Railway	51	1
L. H. Wheaton, Yarmouth, N. S.		
Hocking Valley Railroad	346	1
Wm. Michel, Columbus, O.		
Hoshu Railway of Japan	...	1
Kyoichi Murikami, Osaka, Japan.		
Houston & Texas Central Railroad	508	2
G. A. Quinlan, Houston, Texas.		
J. M. Lee, Houston, Texas.		
Illinois Central Railroad	4,272	34
J. T. Harahan, Chicago, Ill.		
J. F. Wallace, Chicago, Ill.		
A. W. Sullivan, Chicago, Ill.		
W. J. Harahan, Chicago, Ill.		
D. Sloan, Chicago, Ill.		
J. W. Higgins, Chicago, Ill.		
H. W. Parkhurst, Chicago, Ill.		
O. J. Travis, Chicago, Ill.		
C. E. Grafton, Chicago, Ill.		
C. Dougherty, Chicago, Ill.		
H. McCourt, Chicago, Ill.		

Name of Road and Membership.	Mileage.	No. of Members
Illinois Central—Continued.		
H. Baker, Freeport, Ill.		
A. H. Egan, Chicago, Ill.		
J. C. Dailey, Carbondale, Ill.		
D. S. Bailey, Clinton, Ill.		
H. U. Wallace, Louisville, Ky.		
W. S. King, Jackson, Tenn.		
Alvah Philbrick, Memphis, Tenn.		
F. B. Harriman, Dubuque, Ia.		
O. M. Dunn, New Orleans, La.		
H. R. Safford, Clinton, Ill.		
A. E. Harvey, Dubuque, Ia.		
B. J. Gilleas, Carbondale, Ill.		
H. Gilleas, Cherokee, Ia.		
A. M. Shaw, Mattoon, Ill.		
E. I. Rogers, Memphis, Tenn.		
L. A. Downs, Louisville, Ky.		
L. L. Dagron, New Orleans, La.		
H. R. Dill, Evansville, Ind.		
W. B. McLoughlin, Memphis, Tenn.		
L. A. Washington, Paducah, Ky.		
P. Laden, Jackson, Tenn.		
Dennis Sheahan, Memphis, Tenn.		
A. T. Sabin, Fulton, Ky.		
Jacksonville & Southwestern Railway	95	1
Roland Woodward, Jacksonville, Fla.		
Kansas City, Fort Scott & Memphis Railway	1,278	2
R. R. Hammond, Kansas City, Mo.		
J. V. Hanna, Kansas City, Mo.		
Kansas City, Mexico & Orient Railway	365	2
M. P. Paret, Kansas City, Mo.		
W. W. Colpitts, Kansas City, Mo.		
Lake Erie & Detroit River Railway	182	1
Owen McKay, Walkerville, Canada.		
Lake Erie & Western Railway	880	1
G. C. Cleveland, Indianapolis, Ind.		
Lake Shore & Michigan Southern Railway	1,413	4
E. A. Handy, Cleveland, O.		
Samuel Rockwell, Cleveland, O.		
F. E. Bissell, Andover, O.		
R. O. Rote, Cleveland, O.		

Name of Road and Membership.	Mileage.	No. of Members.
Lake Superior & Ishpeming Railway	21	1
J. F. Deimling, Marquette, Mich.		
Lehigh Valley Railroad	1,461	3
Walter Berg, New York, N. Y.		
E. B. Ashby, South Bethlehem, Pa.		
G. F. Morse, Buffalo, N. Y.		
Long Island Railroad	379	1
C. L. Addison, Hempstead, N. Y.		
Los Angeles Terminal Railway	55	1
E. M. Jessup, Los Angeles, Cal.		
Louisville & Nashville Railroad	3,222	2
R. Montfort, Louisville, Ky.		
Seely Dunn, Evansville, Ind.		
Mexican Central Railway	2,054	2
A. A. Robinson, Boston, Mass.		
Lewis Kingman, City of Mexico.		
Mexican International Railway	848	1
C. T. Norton, Porfirio Diaz, Mexico.		
Mexican National Construction Company	89	1
A. P. Herbert, Colima, Mexico.		
Mexican National Railroad	1,331	1
Thos. Purcell, Matamoros, Mexico.		
Michigan Central Railroad	1,642	5
A. Torrey, Detroit, Mich.		
W. S. Kinnear, Detroit, Mich.		
B. Douglas, Detroit, Mich.		
H. D. Miles, Detroit, Mich.		
F. A. Bryan, Niles, Mich.		
Minneapolis & St. Louis Railroad	567	1
H. G. Kelley, Minneapolis, Minn.		
Minneapolis, St. Paul & Sault Ste. Marie Railway	1,039	1
E. Pennington, Minneapolis, Minn.		
Missouri, Kansas & Texas Railway	2,391	1
S. B. Fisher, St. Louis, Mo.		

Name of Road and Membership.	Mileage.	No. of Members.
Missouri-Pacific Railway	5,326	2
H. Rohwer, St. Louis, Mo.		
H. C. Draper, Booneville, Mo.		
Mobile & Ohio Railroad	879	2
C. S. Clarke, Mobile, Ala.		
C. F. Blue, St. Louis, Mo.		
Montana Railroad	100	1
A. G. Lombard, Helena, Mont.		
Nashville, Chattanooga & St. Louis Railway	1,195	4
J. W. Thomas, Jr., Nashville, Tenn.		
Hunter McDonald, Nashville, Tenn.		
W. J. Hills, Paducah, Ky.		
I. O. Walker, Paducah, Ky.		
National Docks Railway	23	1
B. Murtaugh, Jersey City, N. J.		
National Railway of Tehuantepec	192	1
John B. Body, Coatzacoalcos, Mexico.		
New York Central & Hudson River Railroad	6,066	5
W. J. Wilgus, New York, N. Y.		
H. Fernstrom, New York, N. Y.		
J. C. Nelson, New York, N. Y.		
G. W. Vaughan, Jersey Shore, Pa.		
G. S. Cheyney, Buffalo, N. Y.		
New York, Chicago & St. Louis Railway	512	3
A. W. Johnston, Cleveland, O.		
E. E. Hart, Cleveland, O.		
C. B. Hoyt, Bellevue, O.		
New York, New Haven & Hartford Railroad	2,038	2
W. H. Moore, New Haven, Conn.		
E. P. Dawley, Boston, Mass.		
New York, Philadelphia & Norfolk Railroad	112	1
J. G. Rodgers, Cape Charles, Va.		
Norfolk & Southern Railroad	147	1
F. L. Nicholson, Norfolk, Va.		
Norfolk & Western Railway	1,555	1
C. S. Churchill, Roanoke, Va.		

Name of Road and Membership.	Mileage.	No of Members.
Northern Pacific Railway	5,487	2
E. H. McHenry, St. Paul, Minn.		
W. L. Darling, St. Paul, Minn.		
Ocos Railway	30	1
Carlos List, Ocos, Guatemala.		
Ohio River Railroad	269	2
C. E. Bryan, Parkersburg, W. Va.		
L. C. James, Parkersburg, W. Va.		
Pacific Coast Company	178	1
Wendell N. Chase, Seattle, Wash.		
Pennsylvania Lines West of Pittsburg	4,863	9
Thos. Rodd, Pittsburg, Pa.		
R. Trimble, Pittsburg, Pa.		
W. C. Cushing, Pittsburg, Pa.		
R. C. Barnard, Cincinnati, O.		
Paul Jones, Louisville, Ky.		
Nettelton Neff, Columbus, O.		
A. H. Sanford, Allegheny, Pa.		
M. L. Byers, Logansport, Ind.		
C. S. Sims, Chicago, Ill.		
Pennsylvania Railroad	4,287	5
J. T. Richards, Philadelphia, Pa.		
R. Bell, Buffalo, N. Y.		
Geo. Houliston, Buffalo, N. Y.		
L. G. Haas, Mahoningtown, Pa.		
W. S. Thompson, Oil City, Pa.		
Peoria & Eastern Railway	351	2
J. A. Barnard, Indianapolis, Ind.		
M. A. Neville, Indianapolis, Ind.		
Pere Marquette Railroad	1,743	2
Job Tuthill, Detroit, Mich.		
F. H. Alfred, Saginaw, Mich.		
Philadelphia & Reading Railway	1,453	6
W. G. Besler, Reading, Pa.		
Wm. Hunter, Philadelphia, Pa.		
W. A. Garrett, Philadelphia, Pa.		
F. S. Stevens, Reading, Pa.		
J. E. Turk, Reading, Pa.		
Edward Shelah, Philadelphia, Pa.		

Name of Road and Membership.	Mileage.	No. of Members.
Pittsburg & Lake Erie Railroad	180	4
J. A. Atwood, Pittsburg, Pa.		
A. R. Raymer, Pittsburg, Pa.		
E. F. Wendt, Pittsburg, Pa.		
E. W. Boots, McKeesport, Pa.		
Pittsburg & Western Railway	354	1
Paul Didier, Allegheny, Pa.		
Pittsburg, Connellsville & Wheeling Railway	100	1
J. T. Wilson, Moundsville, W. Va.		
Rock Island & Peoria Railway	118	1
W. H. Kimball, Rock Island, Ill.		
St. Louis, Iron Mountain & Southern	1,773	1
William Cotter, St. Louis, Mo.		
St. Louis, Kansas City & Colorado	72	1
G. L. Sands, St. Louis, Mo.		
St. Louis & San Francisco Railway	1,640	2
A. J. Davidson, St. Louis, Mo.		
J. G. Taylor, Peirce City, Mo.		
Santa Fe, Prescott & Phœnix Railway	224	2
J. H. Emmert, Prescott, Ariz.		
W. A. Drake, Prescott, Ariz.		
San Francisco & San Joaquin Valley Railroad	373	1
A. D. Schindler, Stockton, Cal.		
Seaboard Air Line	2,591	2
W. W. Gwathmey, Jr., Portsmouth, Va.		
Blair Burwell, Jr., Jacksonville, Fla.		
South Haven & Eastern Railroad	37	1
G. E. Drew, Three Oaks, Mich.		
Southern Pacific Company	9,202	21
J. Kruttschnitt, San Francisco, Cal.		
W. G. VanVleck, Houston, Texas.		
R. Koehler, Portland, Ore.		
Wm. Hood, San Francisco, Cal.		
J. H. Wallace, San Francisco, Cal.		
E. B. Cushing, Houston, Texas.		
J. A. Naugle, Guaymas, Mexico.		
J. D. Isaacs, San Francisco, Cal.		

Name of Road and Membership.	Mileage.	No. of Members.
Southern Pacific—Continued.		
Geo. Montague, Nogales, Ariz.		
J. L. Frazier, San Francisco, Cal.		
T. Fitzgerald, Ogden, Utah.		
W. A. Grondahl, Portland, Ore		
W. S. Palmer, Oakland, Cal.		
J. B. Robinson, Sacramento, Cal.		
E. L. Swaine, Los Angeles, Cal.		
C. C. Sroufe, Tucson, Ariz.		
W. C. Ambrose, Bakersfield, Cal.		
R. S. Culverwell, San Francisco, Cal.		
I. A. Cottingham, Del Rio, Texas.		
C. C. Mallard, Algiers, La.		
G. A. Mountcastle, Deming, N. M.		
Southern Railway	6,808	6
W. H. Peddle, Washington, D. C.		
D. W. Lum, Washington, D. C.		
C. H. Hudson, Knoxville, Tenn.		
R. Southgate, Salisbury, N. C.		
O. D. Killebrew, Columbia, S. C.		
C. E. Lindsay, Manassas, Va.		
Southwestern Railroad of New Mexico		1
S. P. Hutchinson, New York, N. Y.		
Tennessee Central Railway	55	1
F. M. Bisbee, Nashville, Tenn.		
Terminal Railroad Association of St. Louis	18	1
J. W. Taylor, St. Louis, Mo.		
Terre Haute & Indianapolis Railroad	552	1
F. T. Hatch, Terre Haute, Ind.		
Terre Haute & Logansport Railroad	176	1
V. K. Hendricks, Terre Haute, Ind.		
Toledo & Ohio Central Railway	585	2
T. F. Whittelsey, Toledo, O.		
H. C. Ferris, Columbus, O.		
Toledo, St. Louis & Western Railway	450	1
E. J. Randall, Frankfort, Ind.		
Union Railway	57	1
E. C. Brown, Port Perry, Pa.		

Name of Road and Membership.	Mileage.	No. of Members.
Union Pacific Railroad	3,000	2
E. Dickinson, Omaha, Neb.		
J. B. Berry, Omaha, Neb.		
Union Stock Yards & Railroad Company	50	2
Wm. J. C. Kenyon, South Omaha, Neb.		
W. S. King, South Omaha, Neb.		
Vera Cruz & Pacific Railroad	85	1
Sheldon T. Bent, City of Mexico.		
Wabash Railroad	2,367	1
E. K. Woodward, Detroit, Mich.		
Waycross Air Line	70	1
A. Bonnyman, Waycross, Ga.		
Wellington & Manawatu Railway		1
James Marchbanks, Wellington, New Zealand.		
West Jersey & Seashore Railway	330	1
J. H. Nichol, Camden, N. J.		
Western Railways of Australia	1,355	1
Thos. Watson, Geraldton, W. Australia.		
Wisconsin & Michigan Railroad	72	1
B. C. Gowen, Peshtigo, Wis.		
Wisconsin Central Lines	961	2
R. B. Tweedy, Milwaukee, Wis.		
C. N. Kalk, Milwaukee, Wis.		
Yazoo & Mississippi Valley Railroad	1,047	3
A. J. Greif, Vicksburg, Miss.		
W. W. Hayden, Memphis, Tenn.		
L. W. Baldwin, Memphis, Tenn.		
Miscellaneous		47
Total	172,183	369

APPENDIX TO REPORT ON GRADE CROSSINGS.

STATE LAWS RELATING TO ABOLITION OF HIGHWAY GRADE CROSSINGS, LIGHTING OF CROSSINGS, SIGN-BOARDS, SOUNDING OF BELL OR WHISTLE, ETC.

ALABAMA.

Section 1164. Right to Cross Navigable Streams; to Use, Cross or Change Public Roads.—The corporation is authorized, in the construction of its road, to cross navigable streams or waters, but in the erection and construction of bridges, trestles or other structures must not impair the navigation of such streams or waters; and the corporation is also authorized to use, or to cross, or to change public roads, when necessary, in the building, construction or maintenance of its roadway or track, but must place the public road used, or crossed, or changed, in a condition satisfactory to the authorities of the county having control thereof; but where practicable the track of the railroad must go under or over the public roadway.

ARIZONA.

Section 331. Every railroad corporation shall construct and maintain good and sufficient crossings, where its railroad crosses public roads, or town streets, now or hereafter opened for public use, which crossings shall be constructed of the materials and in the manner following: On each side of each rail be laid a plank of not less than eight inches in width, and the remaining space between the rails shall be macadamized; on the outside of each rail there shall be a macadamized or gravel pavement of not less than six inches in depth and not less than four nor more than ten feet in width, to be determined by the road overseer, street commissioner, or overseer having such public road or street in charge; this pavement to be substantially and properly joined up to the plank provided to be laid on the outside of each rail. And every such corporation shall also cause boards to be placed, well supported by posts and otherwise, and constantly maintained, across each traveled public road or street where the same is crossed by railroad; said boards shall be elevated so as not to obstruct the travel, and to be easily seen by the travelers, and on each side of such board shall be painted in capital letters, of at least the size of nine inches each, the words "Railroad crossing—look out for the cars." If such corporation fail to construct and maintain said crossings or to put up boards as above provided, then the overseers, municipal authorities or parties having legal control or charge of said road or streets, shall notify such corporation of the necessity for the construction thereof, which notice shall be in writing, and shall be served by delivering a copy of the same to the agent of the company most convenient to the crossing; upon the service of such notice, if such corporation fail to construct said crossings or put up said boards within sixty days from the service of said notice, the parties having control or charge of said roads or streets may proceed to construct said crossings or put up said boards as herein provided, and shall be entitled to recover the

amount expended, together with all accruing costs, from such corporation thus refusing or neglecting to construct or put up the same; and such corporation shall be liable for all damages resulting from such neglect to construct such crossings or erect such signboards as are hereby provided for; said damages to be recovered before any court having jurisdiction thereof, by civil action in the name of parties injured or having legal control of said roads or streets. But this section shall not apply to streets in villages or cities, unless the corporation shall be required to put up such boards by the officers having charge of such street.

ARKANSAS.

Section 6196. A bell of at least thirty pounds' weight, or a steam whistle, shall be placed on each locomotive or engine, and shall be rung or whistled at the distance of at least eighty rods from the place where the said road shall cross any other road or street, and be kept ringing or whistling until it shall have crossed said road or street, under a penalty of two hundred dollars for every neglect, to be paid by the corporation owning the railroad, one-half thereof to go to the informer and the other half to the county; and the corporation shall also be liable for all damages which shall be sustained by any person by reason of such neglect.

Section 6197. Every railroad corporation in this state shall cause boards to be placed, well supported by posts or otherwise, and constantly maintained, across each public road or street where the same is crossed by the railroad on the same level. Said boards shall be elevated, so as not to obstruct travel, and to be easily seen by travelers; and on each side of said boards shall be painted, in capital letters of at least the size of nine inches each, the words, "Railroad crossing—look out for the cars while the bell rings or the whistle sounds;" but this section shall not apply to streets in cities or villages, unless the corporation be required to put up such boards by the officer having charge of such streets.

Section 6363, S. & H. Dig., as amended February, 1, 1899. "Whenever any railroad company or corporation has constructed, or shall hereafter construct, a railroad across any public road or highway of this state, now established or hereafter to be established, or where any public road or highway hereafter established shall cross any railroad now established or to hereafter be established, such railroad company or corporation shall be required to so construct such railroad crossing, or so alter or construct roadbed of such public road or highway that the approaches to the railroad-bed, on either side, shall be made and kept at no greater elevation or depression than one perpendicular foot for every five feet of horizontal distance, such elevation or depression being caused by reason of the construction of said railroad; provided, at any crossing of any public highway, such railroad may be crossed by a good and safe bridge, to be built and maintained in good repair by the railroad company or corporation owning or operating such railroad."

CALIFORNIA.

No specific state laws have been enacted with regard to highway grade crossings. The municipal authorities in cities and towns have control of the matter of crossings.

COLORADO.

Section 3700. Trains Must Stop—Speed Allowed.—In all cases where two railroads shall cross each other, every train on approaching such crossing shall come to a full stop immediately before it reaches such crossing, and shall cross such track at a speed not exceeding four miles per hour.

Section 3701. Penalty.—Any and every engineer, conductor or other person, having charge of and running any locomotive or train on any such railroad, who shall violate section 1 of this Act, shall be deemed guilty of a misdemeanor, and on conviction shall be fined in a sum not less than fifty nor more than two hundred dollars for each offense.

No statutory provisions in Colorado relating to the establishment and maintenance of grade crossings at country highways.

Section 4403. Crossings at City Streets.—To license, regulate and control the laying of railroad tracks, to provide for and change the location, grade and crossing of any railroad, and to control, regulate and prohibit the use of steam engines and locomotives propelled by steam power within the corporate limits.

To require railroad companies to fence their respective railroads, or any portion of the same, and to construct cattle-guards at crossings of streets and public roads, and keep the same in repair within the limits of the corporation.

To require railroad companies to keep flagmen at railroad crossings of streets, and provide protection against injury to persons and property in the use of such railroads.

To compel such railroads to raise or lower their railroad tracks to conform to any grade which may at any time be established by such city or town, and when such tracks run lengthwise of any street, alley or highway, to keep their tracks on a level with the street surface, and so that such tracks may be crossed at any place on such street, alley or highway.

To compel and require railroad companies to make and keep open, and to keep in repair, ditches, drains, sewers and culverts along and under their railroad tracks, so that filthy or stagnant pools of water cannot stand on their grounds or right-of-way, and so that the natural drainage of adjacent property shall not be impeded.

Mills' Annotated Statutes, Section 3720. Fencing Right-of-Way—Cattle-Guards—Penalty for Neglect.—Whenever the proprietor or proprietors of any tract or tracts of land shall erect fences upon the same, on the same line ending at the line of right-of-way of any railroad passing through, across or between such tract or tracts of land, it shall be the duty of such railroad company, or the company or persons operating or controlling such railroad, to fence across the said right-of-way, so as to connect such fences, and to insert cattle-guards therein, within thirty days after request made therefor by the proprietor of said lands, or either tract thereof; provided, that the proprietor of said land shall deposit with said railroad company, or person operating said railroad, the estimated cost thereof, to be furnished within ten days after application made therefor. And every such company or person,for every day during which it or he shall fail to comply with such demand, after the lapse of thirty days next thereafter, shall be liable to a penalty of twenty dollars, which may be recovered in the name of The People, for the use of the person aggrieved.

Section 3721. Demand Made in Writing.—No such demands shall be effectual unless made in writing and served upon the superintendent, division superintendent, or some station agent of the company, or persons at the time operating such railroad.

No provision in the statutes of this state requiring cattle-guards at highway crossings, nor regarding signboards.

No provisions relating to the sounding of bell or whistle at crossings.
No provisions relative to abolition of grade crossings.

CONNECTICUT.

Section 1. Every railroad company, after its line of road shall have been located, approved, and established, may alter the grades of its lines, and may raise any highway bridges that pass over the tracks to such height as may be approved by the railroad commissioners, upon application made to them for such approval, and may change the grade of the approaches to such bridges so as to conform to the change in the height of the bridges; but no railroad company may, under the provisions of this act, raise the grade of its tracks so as to lessen the height of an existing bridge over its tracks, without the approval of the railroad commissioners.

Section 2. Damages accruing to any adjoining proprietor on account of any change of grade on the highways which are approaches to any railroad bridge, raised under the provisions of this act, shall be assessed and paid by the railroad companies in accordance with the provisions of chapter 220 of the public acts of 1889.

Section 3424. The railroad commissioners, when requested in writing by the selectmen of any town, the mayor and common council of any city, or the warden and burgesses of any borough (in cases where the borough has charge of the highways within the same), to order a gate or electric signal to be erected, or a flagman to be stationed at any railroad crossing within their respective towns, cities, or boroughs, shall visit such place, first giving the authorities making such request reasonable notice thereof, and if the public safety requires it, shall order the company operating said railroad to maintain a gate or electric signal, or to keep a flagman at said place, or to do any other act at said place needful for the protection of the public, and may specify when said gate shall be opened and closed, or when flagmen shall be on duty, and may change any such order when they deem it necessary, first visiting the town, city, or borough in which said crossing is located, and there giving the authorities thereof an opportunity to be heard thereon; and if any railroad company shall neglect to station flagmen, or maintain gates or electric signals as ordered by said commissioners, or shall neglect to comply with any order of said commissioners provided for by this section, it shall forfeit to the state $50 for each day of such neglect.

Section 3425. When the railroad commissioners, on application as provided in the preceding section, shall make an order as provided therein, or refuse to make the same, their decision shall be communicated to the parties in interest within 30 days from the final hearing on the same, and either party aggrieved by such decision may appeal therefrom to the Superior Court, in the manner and with like effect as provided for appeals in section 3518, and in all cases in which on an appeal, as aforesaid, an order shall be passed by the Superior Court, said court may at any time upon the application of either party, with due notice to adverse parties, annul or vary such order; provided, that said court shall find that there has been a change of circumstances surrounding said crossing.

Section 3462. When any railroad company shall take land for railroad purposes, the effect of which is to cut off other land from practical access to the highway, said railroad may, with the approval of the railroad commissioners, take additional land, sufficient to procure a convenient way from the land so cut off to the highway, and shall provide for the use of the owner of the land cut off as aforesaid a suitable way over such additional land to the highway. Said way shall remain a private way for the use of the owner of the land cut off as aforesaid, and

the city or town in which it is situated shall not be liable for its maintenance nor responsible for its defects. For the purposes of this section lands may be acquired in the manner provided by law for the taking of land by railroad companies.

Section 1. On and after the passage of this Act, any public highway crossing over a railroad, the use of which crossing has been abandoned for a period of at least fifteen years, shall be deemed discontinued.

Section 2. Whenever a farm or private crossing has been removed by any railroad company without the consent of the owner or owners, the railroad company from whose tracks said crossing has been removed shall restore the same in good order upon written request of the owner or owners, under a forfeiture of $5 per day to the person or persons owning or having a right to use such crossing, after 30 days from the date of such notice.

Section 3476. When it shall be necessary for the construction of a railroad to intersect or cross any watercourse not navigable, or any public highway, the railroad company may construct said railroad across or upon the same if the railroad commissioners shall judge it necessary; but said company shall restore said watercourse or highway thus intersected to its former state, or in a sufficient manner not to impair its usefulness; and in case any highway is so located that said railroad cannot be judiciously constructed across or upon the same without interfering therewith, said company may, with the consent of said commissioners, cause such highway to be changed or altered, so that said railroad may be made on the best site for that purpose; but said company shall put such highway in as good situation and repair as it was previous to such alteration under the direction of said commissioners, whose determination thereon shall be final.

Section 3478. Every railroad company shall keep and maintain at each crossing at grade of any highway, at which there is no gate, warning boards of such a description as the railroad commissioners may approve.

Section 3479. When any highway or street shall be changed or altered by any railroad company with the consent of the railroad commissioners, and it shall be necessary to take any land for a highway to which such company has not obtained title, and over which neither said company nor the town in which such change shall be made has any right of way, and said company is unable to agree with the owner thereof in regard to the amount of damages to be paid therefor, the same proceedings shall be had for the purpose of procuring the required right of way as are provided by law in regard to taking land for railroad purposes.

Section 3480. Every railroad company which may locate and construct a railroad across any turnpike, highway, or public street, shall construct it so as to cross over or under the same; and may, under the direction of the railroad commissioners, raise or lower the same at said crossing, or change the location thereof; and shall make and maintain such bridges, abutments, tunnels, arches, excavations, embankments, and approaches, as the railroad commissioners shall order, and the convenience and safety of the public travel upon said turnpike, highway, or street may require; but the railroad commissioners may, upon due notice to said company and to the selectmen of the town or mayor of the city in which said crossing is situated, direct such company or trustee to construct its railroad at such crossing upon a level with the turnpike, highway, or street; but no such direction shall be given in any case, except for special reasons which shall be recorded in the records of the railroad commissioners.

Section 3481. When a new highway or a new portion of a highway shall hereafter be constructed across a railroad, such highway or portion of highway shall pass over or under the railroad, as the railroad commissioners shall direct. The railroad company operating such railroad shall construct such crossing to the approval of the railroad commissioners, and may take land for the purposes of this section in the manner provided by law for the taking of lands by railroad companies. One-half the expense of such crossing shall be borne by the company constructing the same, and one-half thereof shall be paid to said company by the town, city, or borough which constructs such highway or portion of highway. If said highway shall cross over said railroad the structure necessary therefor shall be maintained and kept in repair by the party bound to maintain said highway; but if it shall cross under said railroad such structure shall be maintained and kept in repair by said company.

Section 3482. When a highway, or portion of a highway, has been or shall be laid out or ordered to be laid out across a railroad, and the railroad commissioners shall direct such highway to be carried over the railroad, they shall determine the length, width, and material of the bridge over the railroad before the damages that may be occasioned to any person by the taking of land for such highway are finally assessed; and said commissioners may require such bridge to extend beyond the railroad crossed by it; but in cases pending June 1, 1897, said commissioners may determine the length, width and material of such bridge at any stage of the proceedings. And no structure shall hereafter be constructed or reconstructed over and across any railroad until the railroad commissioners shall have determined the length, width, material, and plan of such structure and its height above the roadbed of such railroad, and the necessity for such construction or reconstruction.

Section 1. The selectmen of any town, the mayor and common council of any city, the warden and burgesses of any borough within which a highway crosses or is crossed by a railroad, or the directors of any railroad company whose road crosses or is crossed by a highway, may bring their petition in writing to the railroad commissioners, therein alleging that public safety requires an alteration in such crossing, its approaches, the method of crossing, the location of the highway or crossing, the closing of a highway crossing and the substitution of another therefor, not at grade, or the removal of obstructions to the sight at such crossing, and praying that the same may be ordered; whereupon the railroad commissioners shall appoint a time and place for hearing the petition, and shall give such notice thereof as they judge reasonable to said petitioner, the railroad company, the municipalities in which such crossing is situated, and to the owners of the land adjoining such crossing and adjoining that part of the highway to be changed in grade; and after such notice and hearing, said commissioners shall determine what alterations, changes, or removals, if any, shall be made and by whom done; and if the aforesaid petition is brought by the directors of any railroad company, or in behalf of any railroad company, they shall order the expense of such alterations or removals, including the damages to any person whose land is taken, and the special damages which the owner of any land adjoining the public highway shall sustain by reason of any change in the grade of such highway, in consequence of any change, alteration, or removal ordered under the authority of this Act, to be paid by the railroad company owning or operating the railroad in whose behalf the petition is brought, and in case said petition is brought by the selectmen of any town, the mayor and common council of any city, or the warden and

burgesses of any borough, they may, if the highway affected by said determination was in existence when the railroad was constructed over it at grade, or if the layout of the highway was changed for the benefit of the railroad after the layout of the railroad, order an amount not exceeding one-quarter of the whole expense of such alteration, change, or removal, including the damages, as aforesaid, to be paid by the town, city or borough in whose behalf the petition is brought, and the remainder of the expense shall be paid by the railroad company owning or operating the road which crosses such public highway; if, however, the highway affected by such order, last mentioned, has been constructed since the railroad which it crosses at grade, the railroad commissioners may order an amount not exceeding one-half of the whole expense of such alteration, change, or removal, including the damages, as aforesaid, to be paid by the town, city, or borough in whose behalf the application is brought, and the remainder of the expense shall be paid by the railroad company owning or operating the road which crosses such public highway. The directors of every railroad company which operates a railroad in this state shall remove or apply for the removal of at least one grade crossing each year for every 60 miles of road operated by it in this state, which crossings, so to be removed, shall be those which in the opinion of said directors are among the most dangerous ones upon the lines operated by it, and if the directors of any railroad company fail so to do, the railroad commissioners shall, if in their opinion the financial condition of the company will warrant, order such crossing or crossings removed as in their opinion the said directors should have applied for the removal of under the above provisions, and the railroad commissioners in so doing shall proceed in all respects as to method of procedure and assessment of expenses as if the said directors had voluntarily applied therefor.

Section 2. The railroad commissioners may in the absence of any application therefor, when in their own opinion public safety requires an alteration in any highway or highways crossed at grade by a railroad or by railroads belonging to or operated by more than one company, after a hearing had upon such notice as they shall deem reasonable to the railroad company or companies owning or operating said railroad or railroads, and to the selectmen of the town, mayor of the city, or warden of the borough within which said highway or highways are situated, and to the owners of the land adjoining said crossing, order such alterations in such highway or highways as they shall deem best, and shall determine and direct by whom such alterations shall be made, at whose expense, and within what time; provided, that in all cases arising under this section one-fourth of the expense, including damages and special damages, as aforesaid, shall be paid by the state and the remainder shall be assessed upon the railroad company or companies benefited by such order; and provided, that such alterations as are thus made at the primary instance of the railroad commissioners shall not be ordered so as to direct the construction of more than one bridge in any one year on any one railroad.

Section 4. Whenever the railroad commissioners, upon an application brought under the provisions of section 1 of this Act, shall find that any highway crosses or is crossed by the tracks of more than one railroad, and the tracks of such railroads are so near together that public convenience requires the work of separating the grades to be done under and in compliance with one order, they shall give notice to all the companies operating said railroads to appear before them and be heard upon the application, and after such notice and hearing said commissioners shall determine what alterations shall be made, if any, so as to separate the grades of all of said crossings at the same time, and they shall determine

by whom such work shall be done, and they shall apportion the expense to be borne by the railroad companies between such companies in such manner as they, the said commissioners, shall deem proper.

Section 5. Damages under the provisions of this Act on account of any change of grade in highways shall be assessed in the same manner as in the case of land taken for railroad purposes; and the provisions of this Act in relation to such damages for change of grade shall apply in the case of any order passed by the railroad commissioners or Superior Court since June 1, 1887, under the authority conferred by section 3489 of the general statutes.

Section 1. It shall be the duty of railroad companies to maintain and keep in repair all structures heretofore or hereafter erected over their tracks at any highway crossing, and the approaches to the crossings when the same are made with plank surface, and also to keep in repair the surface of the highway, including the planking or other surface material of the highway upon such structure, and it shall be the duty of the municipality where such bridge or bridges are located to notify any agent of the railroad company owning such bridge or bridges or structure of any defect in the same, and such notice shall be in writing.

Section 1. No order shall be issued by the selectmen of any town authorizing or requiring a change of grade in any public highway, or the location or the relocation of any railroad tracks in a public highway, as authorized by section 3 of chapter 169 of the public acts of 1893, except upon a majority vote of all the selectmen after a public hearing, of which at least five days' notice shall have been given, with the nature of the proposed change and the location of the same fully set forth therein.

Section 3486. When a railroad has been laid out or located so near to a highway and in the same general direction as, in the opinion of the selectmen of any town, warden of any borough, or mayor of any city, within which the said highway is situated, to endanger public travel, the said selectmen, warden, or mayor may bring their petition to the railroad commissioners, setting forth the same; and the said commissioners, after reasonable notice to the railroad company to appear and be heard in relation thereto, shall, if in their opinion public safety so requires, and a change of the location of such highway is practicable, forthwith order said railroad company to make said change, in such manner as the commissioners may determine; and such change, including the cost of fencing such relocated highway, shall be done at the expense of said railroad company.

Section 3487. In case any railroad has been heretofore constructed so near any highway in any town, city, or borough, as, in the opinion of the selectmen, mayor, or warden of such town, city, or borough, respectively, to endanger public travel, said selectmen, mayor, or warden may bring their petition to the railroad commissioners, who shall inquire into the facts, and if in their judgment public safety so requires, may order the location of said highway to be changed, and determine by whom the work shall be done, and the expense of such change, including the cost of fencing, shall be paid equally by said town, city, or borough, and said railroad company.

Section 1. The railroad commissioners shall have power to order the location of a highway to be changed, when they find such location endangers public travel, upon petition brought by any railroad company, and they shall have power to make orders for the relocation of any such

highway, when the petition is brought by a railroad company, to the same extent as if such petition were brought under section 3487 of the general statutes by the municipal authorities of any city or town; provided, however, that whenever a petition is brought to them under the provisions of this act by a railroad company the entire expense of making the changes shall be paid by the railroad company which brings the petition.

Section 2. Whenever the railroad commissioners shall order a change in the location of any highway under the provisions of section 3487 of the general statutes, or under the provisions of this Act, and the parties ordered by the railroad commissioners to do the work cannot obtain the necessary land by agreement with the parties interested therein, the railroad company, or the town, city, or borough ordered to do the work, may take the land necessary for carrying out the orders of the railroad commissioners in the same manner as lands are taken for railroad purposes under section 3464 of the general statutes.

Section 3488. When the railroad commissioners, in accepting the layout of any railroad company, have in such acceptance provided that portions of such railroad should not be constructed until certain highways should be relocated, changed, or altered by such railroad company, and the obligation of repairing or maintaining the whole or any part of such highways devolves by law upon any person or corporation other than the town, city, or borough within which such highway may be located, such provision of said commissioners shall be binding upon said railroad company, and it shall be the duty of said railroad company to maintain and repair said highway so relocated, altered, or changed, in the same manner and to the same extent that such other person or corporation was bound to repair and maintain the same before such relocation, change, or alteration. For the purposes of this and the two preceding sections, land may be acquired in the manner provided by law for the taking of land by railroad companies. Any such railroad company may use the material and abutments of any existing bridge, in the old highway, in the construction of a bridge in the substituted highway, and shall provide suitable temporary accommodations for public travel over the old highway until the new highway is completed, and shall be solely responsible for injuries resulting from its negligence in the matter of such temporary accommodations. The selectmen of any such town are hereby authorized to discontinue such parts of the old highway as in their judgment are not of common convenience and necessity.

Section 3492. The railroad commissioners are empowered and authorized to order any railroad company not to use for switching purposes, nor for standing trains of any kind, such portion of its tracks upon or across any public street or highway as in their opinion the public convenience requires should not be so used, and may limit the number of tracks, other than main tracks, which a railroad company may lay upon or across a public street or highway for sidetracks or for switching purposes, and may order a railroad company to remove such of the sidetracks or switching tracks now laid upon or across any public street or highway as said commissioners may deem public convenience or safety requires should be removed.

Section 3493. Said commissioners, when requested in writing by the selectmen of any town, the mayor and common council of any city, or the warden and burgesses of any borough, to forbid the use for switching purposes of the tracks of any railroad company where the same cross any public street or highway within said town, city, or borough, shall visit such crossing, first giving reasonable notice to the authorities mak-

ing such request, and, if public convenience requires, shall order the company operating said railroad not to use the same or such part thereof as may be specified in said order for switching purposes, and may make any order regulating such switching that they shall deem proper, and, upon like application and notice, shall make such orders in regard to the laying of railroad tracks for sidetracks or for switching purposes upon or across such streets or highways, or for the removal of such tracks already laid, as they may judge proper. Said commissioners may change any such order when they deem it necessary, first visiting said town, city, or borough, and giving the authorities thereof an opportunity to be heard thereon.

Section 3498. The railroad commissioners are empowered to make orders for the regulation of the speed at which railroad locomotives and cars shall cross streets and highways; and orders regulating the obstruction of streets and highways by railroad locomotives and cars; and generally to make any and all orders regarding the crossing of streets and highways by railroad locomotives and cars, that the public may be inconvenienced as little as possible thereby. Every railroad company which shall violate any such order shall forfeit to the state $50 for each day of such violation.

Section 3499. When any railroad is crossed by a highway on a level therewith, the company operating said railroad shall, at its own expense, so guard or protect its rails by plank, timber, or otherwise as to secure a safe and easy passage across its road. And if the selectmen of any town, the mayor of any city, or the warden of any borough shall represent in writing to the railroad commissioners that any company has failed to comply with the requirements of this section in regard to any highway within their town, city, or borough, respectively, said commissioners shall examine said crossing and make such order as they may deem necessary to carry out the provisions of this section.

Section 3500. All covered bridges constructed on the line of any railroad shall not be less than 18 feet in height from the top surface of the rail laid in the track on the bridge to the underside of the cross-beams overhead.

Section 3501. Every railroad company shall, if required by the railroad commissioners, erect and thereafter maintain suitable bridge guards at every bridge over its railroad less than 18 feet in height above the tracks; such bridge guards to be approved by the railroad commissioners, and to be erected and adjusted to their satisfaction.

Section 3504. Fences.—Every railroad company shall construct suitable cattle-guards and fences therefrom at all crossings of passways or highways, to prevent cattle from passing upon its railroad, except when the railroad commissioners deem it unnecessary.

Section 2274. No barbed wire shall be used within five feet of the ground along any sidewalk or public highway, without the written consent of a majority of the selectmen of the town, the members of the common council of the city, or the warden and burgesses of the borough in which such sidewalk or highway is situated.

Section 3539. Every railroad company which shall permit a violation of the two preceding sections shall forfeit to the state for every such violation the sum of $50.

Section 3540. Every railroad company shall not allow any handcar, or other car not moved by steam belonging to it, and used upon its railroad, when removed from the railroad track (except when placed in a

building prepared for it), to remain within 50 feet of any road or highway crossing said tracks.

Section 3553. Every engine used upon any railroad shall be supplied with a bell of at least 35 pounds' weight, and a suitable steam whistle, which bell and whistle shall be so attached to such engine as to be conveniently accessible to the engineer, and in good order for use.

DELAWARE.

Section 81. Crossings, Switches, Signals, Etc.—That any railroad corporation created under this act which shall have duly located the route of its railroad by a survey deposited in the office of the secretary of state, as required by section 79, shall have power in the construction of its said railroad on such route to cross any canal, navigable stream or watercourse between its terminii, but in such manner as not unnecessarily to impede the navigation and use thereof; and shall also have power to cross any railroad or railway intervening between such terminii and acquire the necessary easement for such crossing, either by agreement with the corporation owner thereof, or, on failure to agree, by condemnation proceedings in the manner prescribed by section 78. Provided, however, that whenever practicable so to do, the crossing at grade of any railroad or railway shall be avoided, but if not practicable, the crossing may be at grade, subject to the further provisions made by this section, and in that event it shall be the duty of the corporation whose railroad track or tracks shall cross the track or tracks of such other railroad or railway company, at its own expense to erect and maintain at such crossing a signal tower and signals of a generally approved pattern, with an electric warning attachment, and also to maintain an interlocking system with derailing switches, and keep a competent watchman and switchman on duty thereat; and the trains of the crossing company shall come to a full stop at least 200 feet from the tracks of the railroad or railway crossed; and the trains or cars of the company owning or operating the railroad or railways so crossed at grade shall have precedence and priority of movement over the trains of the company constructing the crossing. And, provided, further, that no such grade crossing shall be permitted or effected until the question of the practicability of an overhead or undergrade crossing shall have been considered and determined by the chancellor, who shall, upon the petition or bill of the company desiring to effect such crossing at grade, have full power and jurisdiction upon notice to and answer by the company whose tracks are proposed to be crossed, to hear and determine the matter by an appropriate decree, either refusing or permitting the crossing at grade, and if permitted to prescribe and regulate by such decree the manner and character of the said crossing, together with such safeguards against collisions thereat, in addition to those by this section provided as he may deem proper, with the right of appeal from the chancellor's decree to the Supreme Court by either party, as in other cases in equity.

Section 84. Fences, Cattle-Guards, Etc.—Every corporation created under this Act, for the construction of a railroad, shall erect and maintain fences on both sides of its road, of the height and strength of a fence required by law, with openings or gates or bars therein, at farm crossings of the road for the use of proprietors of lands adjoining such railroad; and shall also construct and maintain cattle-guards at all road crossings suitable and sufficient to prevent cattle and other animals from getting on the railroad; and until such fences and cattle-guards shall be duly made, the corporation shall be liable for all damages which

shall be done by their engines and cars to cattle, horses or other animals thereon; and after such fences and guards shall be duly made and maintained the corporation shall not be liable for any such damages, unless negligently or wilfully done; and if any person shall ride, lead or drive any horse or other animal upon such railroad and within such fences and guards other than at farm crossings without the consent of the corporation, he shall for every such offense forfeit a sum not exceeding $10, and shall also pay all damages which shall be sustained thereby to the party aggrieved; it shall not be lawful for any person other than those connected with or employed upon the railroad to walk along the track or tracks of any such railroad, except when the same be laid along public roads or streets.

Section 89. Signal Boards.—Every railroad corporation formed under this Act shall cause signal boards, well supported by posts, or otherwise, at such heights as to be easily seen by travelers, and not obstructing travel, containing on each side, in capital letters, at least five inches high, the following inscription: "Railroad Crossing," to be placed and constantly maintained at such public highway, where it is crossed by the railroad at the same level; but such board need not be put up in cities or towns, unless required by the authorities thereof.

Section 90. Gates, Flagmen, Etc.—Whenever, in the opinion of the authorities of any city or incorporated town, the public interest requires that a gate be erected and maintained, or a flagman stationed and kept at the place where any highway or street is crossed, within the corporate limits of such town or city, by any railroad constructed under this Act, they shall give the superintendent or manager of the railroad written notice that the same is required, and the corporation shall, within the time prescribed in such notice, erect and maintain at such crossing the style of gate directed in said notice, and keep a man in charge of the same during such hours as the said authorities may designate, or keep a flagman at such crossing during such hours as they may require. And the said authorities may authorize the discontinuance of such gate or flagman whenever in their judgment the public interest no longer requires the same.

Section 113. Bridges and Passages.—It shall be the duty of every railway corporation organized under this Act to construct and keep in repair good and sufficient bridges and passages over, under or across the said railway or right of way where any public or other road, street or avenue now or hereafter laid out shall cross the same, so that public travel on the said road shall not be impeded thereby; and it is further provided, that such bridges shall be of such width and character, as shall be suitable to the locality in which the same are situated; and also where the said railway shall intersect any farm or lands of any individual, to provide and keep in repair suitable and convenient wagonways over, under and across the said railway, and shall also construct and maintain suitable and proper cattle guards at all road crossings; provided always, that in case any such railway shall cross any street or streets, highway or highways in any city or incorporated town, it shall be either above or below the grade of said street or streets, highway or highways, at such distance as shall not interfere with the free and uninterrupted use of such street or streets, highway or highways; provided further, that the council of any city or the commissioners of any incorporated town, or other persons having authority or control over said highways and streets respectively, may grant permission to said corporation to cross such street or streets, highway or highways, within the limits of the respective city or incorporated town at grade, if they shall deem it to be for the best interest of the city or incorporated

town; and further provided, that in the event that such corporation shall not, within a reasonable time after notification from the council of the city or commissioners of the incorporated town or other persons having authority or control over said highways and streets respectively in which such bridges and passages are to be constructed or repaired, proceed to construct or repair the same as required by this Act, the said council or commissioners or other persons having authority or control over said highways and streets respectively may, in the corporate name of such city or town, institute proceedings in the Court of Chancery against such corporation to compel the specific performance of the duties imposed upon such corporation by this section of this Act, and in case a decree shall be made against such corporation in said proceedings, commanding it to specifically perform said duties within such time, the chancellor, upon proof of such neglect or refusal, may, in his discretion, issue a writ of injunction to restrain said corporation from the exercise of any franchise or the transaction of any business in this state until the said corporation shall have obeyed the command of such decree and paid the costs of said proceedings; and further provided, that the said council or commissioners or other persons having authority or control over said highways and streets respectively, in the event of the failure of such corporation to construct or repair such bridges or passages within a reasonable time after notification as aforesaid, may, if they deem it advisable so to do, proceed themselves to construct and repair such bridges or passages, and when the costs thereof shall have been ascertained, the same may be collected of and from said corporation by said council or commissioners or other persons having authority or control over said highways and streets respectively, by an action at law in any court of competent jurisdiction; provided further, that the permission of the council of any city or the commissioners of any incorporated town or other persons having authority or control over said highways and streets respectively, hereinbefore referred to, shall not be necessary for the purpose of crossing any street or streets, highway or highways at grade, unless said street or streets, highway or highways, at the point where said railway shall cross or at some point between the crossing of said railway and the nearest terminus of said street or streets, highway or highways, shall be in actual use by and for pedestrians and teams at the time of the acquirement of the right of way of said railway across such street or streets, highway or highways.

Section 114. Crossings, Etc.—That any railway corporation created under this Act, which shall have duly located the route of its railway by a survey deposited in the office of the secretary of state, as required by section 112, shall have power in the construction of its said railway on such route, to cross any canal, navigable stream or watercourse between its terminii, but in such manner as not unnecessarily to impede the navigation and use thereof; and shall also have power to cross any railway or railroad intervening between such terminii and acquire the necessary easement for such crossing, either by agreement with the corporation owner thereof, or, on failure to agree, by condemnation proceedings. Provided, however, that whenever practicable so to do, the crossing of any railroad at grade shall be avoided, but if not practicable, the crossing may be at grade, subject to the further provision in this section contained, and in that event it shall be the duty of the corporation whose railway track or tracks shall cross the track or tracks of the railroad company, to so construct its railway track or tracks, as that on each side of the right of way of the railroad company so crossed and at a safe and convenient distance therefrom, there shall be a discon-

nection in each rail of the railway tracks capable of being connected by means of a switch arrangement, whereby the said railway tracks may be made continuous for the passage of the cars of the railway company over the right of way and tracks of the railroad company, which shall be operated at the expense of the railway company, by a competent agent thereof, who shall always be on duty at said crossing for this purpose; and, provided further, that no such grade crossing shall be permitted or effected until the question of the practicability of an overhead or undergrade crossing shall have been considered and determined by the chancellor, who shall, upon the petition or bill of the company desiring to effect such crossing at grade, have full power and jurisdiction upon notice to and answer by the company whose tracks are proposed to be so crossed to hear and determine the matter by an appropriate decree, either refusing or permitting the crossing at grade, and, if permitted, to prescribe and regulate by such decree the manner and character of the said crossing, together with such safeguards against collisions thereat in addition to those by this section provided for as he may deem proper, with the right of appeal from the chancellor's decree to the Supreme Court by either party, as in other cases in equity; and provided further, that any railway may cross any other railway either at grade or overhead or under grade by an adequate structure, which, if under grade, shall be so located and constructed as not to disturb the roadbed so intersected, or, if overhead, shall be at such an elevation as not to impede or interfere with the free and safe passage of the cars on the railway so crossed.

Section 119. Signal Boards.—Every railway corporation formed under this Act shall cause signal boards, well supported by posts, or otherwise, at such heights as to be easily seen by travelers, and not obstructing travel, containing on each side in capital letters, at least five inches high, the following inscription: "RAILWAY CROSSING," to be placed and constantly maintained at such public highway where it is crossed by the railway at the same level; but such boards need not be put up in the cities or towns, unless required by the authorities thereof.

Any corporation failing to comply with or violating or permitting any of its employes or agents to violate any of the provisions of this section shall, in addition to subjecting itself to any damages that may be caused by such failure or violation, be guilty of a misdemeanor, and, upon conviction thereof, be fined for each failure or violation not less than $100 nor more than $500.

FLORIDA.

Section 2264. To Post Sign and Ring Bell at Road Crossings.—Every railroad company, whenever its track crosses a highway, shall put up large signboards at or near said crossing, with the following inscription in large letters on both sides of the boards, "Look Out for the Cars!"

Section 2271. Railroads to Be Fenced.—Every railroad company or other corporation, and every person now operating or running any railroad in this state, or that hereafter may operate or run any railroad in this state, shall erect and maintain substantial fences on the sides of said railroad, except through towns and cities, unless said towns and cities require the same, sufficient to exclude and turn all live stock therefrom, with stockguards at all public crossings, and at such other crossings as may be necessary for the use of owners or tenants of land adjoining such railroads, and in case of failure to erect and maintain said fences and stockguards as aforesaid, such corporation or person shall be liable for all

damages which shall be done by its or his engines or cars to any live stock, whether negligently or not, and suit to recover such damages may be brought in any court of this state having competent jurisdiction by the person having the general property or special property in said live stock, but nothing in this section shall be construed as to authorize two suits by different parties for the same cause of action.

Section 2264. To Post Sign and Ring Bell at Road Crossings.—In all incorporated cities the said company shall cause the bell on the engine to be rung before crossing any of the streets of a city, and their trains shall not go faster through any of the traveled streets of a city than at the rate of four miles per hour."

Section 2265. Penalty for Violating Regulation.—In case any railroad or canal company, or its agents, servants, or employes, shall neglect or refuse to comply with any of the provisions of this chapter (1), or of chapter 2, such railroad or canal company shall, for each or every violation, or refusal, forfeit and pay the sum of fifty dollars, said penalty to be collected by suit and to be paid into the county treasury of the county where such action is brought for the benefit of the school fund.

GEORGIA.

Section 2243. Farm Crossings and Cattle-guards.—Railroad companies to build and maintain farm crossings, etc.: Every railroad company shall be required to build and maintain, at its own expense, good and sufficient cattle-guards on each side of every public road or private way, established pursuant to law, and on the dividing line of adjoining land-owners, where the railroad may cross such public roads, private ways or dividing lines, when necessary to protect said lands. Thirty days' written notice to build such cattle-guards shall be served on any agent or officer of such company, by the owner of the lands to be affected by such cattle-guards; said notice shall be directed to said railroad company, and contain a description of the point where such cattle-guard is desired, be signed by the said land-owner or his agent or attorney, and attested by some officer with a seal; a certified copy of the same being prima facie evidence of the contents of the original notice.

Section 2244. Liability for Failure.—If the railroad company shall fail to build such cattle-guards within 30 days, then the railroad company shall be liable to the owner of the land for all damages resulting from the failure so to build; and for each day elapsing after the 30 days have expired, until the said cattle-guard is built, in the sum of $25, to be recovered by said land-owner in any court having jurisdiction over the same.

Section 2245. Additional Cattle-guards.—Whenever the owner of any lands over which any railroad company may have acquired the right-of-way, may desire additional cattle-guards other than those provided for in the preceding section, or any farm crossing on his land, it shall be the duty of the railroad company, upon written notice, as provided in the preceding section, within 10 days after the service of the said notice, to submit to the land-owner, or his agent, if to be found, a written estimate of the cost of such cattle-guard or farm crossing; whereupon the said land-owner, or his agent, if satisfied with the same, shall pay to the company the sum so estimated, when the company shall at once proceed to build such cattle-guards or farm crossing; the cost of the farm crossing to cover only the roadbed of the said railroad. In the event the land-owner and the company cannot agree as to the correctness of the said estimate, then the same shall be deter-

mined in the same manner as damages for right-of-way. The award may be had at the instance of the land-owner, or his agent, as well as at the instance of the railroad company. In the event the railroad company shall fail to comply with the provisions of this section, or to keep in good repair the guards or crossings, it shall be liable for all damages resulting to such land-owner by the failure to build or keep in good repair such cattle-guards or farm crossings, to be recovered in any court having jurisdiction thereof.

Section 2246. Does Not Affect Existing Laws.—Nothing in the two preceding sections shall be construed in any way to change the liability of railroad companies for damages to live stock, or to prevent land-owners from joining their fences to stock gaps, or of free access from and to the said farm crossing. This and the two preceding sections shall not apply to any roads, ways or crossings within the limits of any incorporated town or city.

Section 2222. A Post to Be Erected.—There must be fixed on the line of said roads, and at the distance of 400 yards from the center of each of such road crossings, and on each side thereof, a post, and the engineer shall be required, whenever he shall arrive at either of said posts, to blow the whistle of the locomotive until it arrives at the public road, and to simultaneously check and keep checking the speed thereof, so as to stop in time, should any person or thing be crossing said track on said road.

Section 2223. Negligence to Erect Such Posts.—Should any company fail or neglect to put up said posts, the superintendent thereof shall be guilty of a misdemeanor.

Section 2224. Failing to Blow the Whistle.—If any engineer neglects to blow said whistle as required, and to check the speed as required, he is guilty of a misdemeanor; provided, that, within the corporate limits of the cities, towns and villages of this state, the several railroad companies shall not be required to blow the whistle of their locomotives on approaching crossings or public roads in said corporate limits, but in lieu thereof the engineer of said locomotive shall be required to signal the approach of their trains to such crossings and public roads in said corporate limits, by tolling the bell of said locomotive, and on failure to do so, the penalties of this section shall apply to such offense.

Section 2225. Injuries.—When such injury occurs, the onus is upon the company to prove such fault on the part of the injured persons.

Section 518. Within Corporate Limits, Bell to Be Tolled.—Railroad companies shall not be required to blow the whistle of their locomotives on approaching crossings or public roads within the corporate limits of any city, town, or village, but in lieu thereof the engineer shall signal the approach of the train to such crossings and public roads by tolling the bell of the locomotive, and on failure to do so, he shall be punished as for a misdemeanor.

Section 2226. Railroad Crossings.—All railroad companies shall keep in good order, at their expense, the public roads or private ways established pursuant to law, where crossed by their several roads, and build suitable bridges and make proper excavations or embankments, according to the spirit of the road laws.

Section 2227. Railroads Over Which Crossings Are Required.—When any road over which a crossing is required shall be obstructed, or not in good order at such crossing, a road commissioner, or an overseer of the road district where the crossing is, must notify the nearest agent or employe of the company, in writing, to remove such obstructions, or to put such crossing in proper order, within 15 days from the date of such notice.

Section 2228. Requisition, When to Be Complied With.—If such requisition is not complied with, it must be done by the overseer of the road, and within 5 days after he shall have discharged such duty, he must report under oath, in writing, to the commissioner of the district, the amount and value of the services performed.

Section 2229. Execution Shall Issue.—The commissioners shall then issue execution, under their hands and seals, directed to any lawful officer, for the amount of such value and the costs of the proceeding, against such defaulting railroad company, as in case of other road defaulters.

[There are no provisions in this state relating to signboards at railroad crossings.]

"To construct its road across, along or upon, or to use any stream of water, watercourse, street, highway or canal, which the route of its road shall intersect or touch; provided, no railroad shall be constructed along and upon any street or highway without the written consent of the municipal or county authorities, and whenever the track of any such road shall touch, intersect or cross any road, highway or street, it may be carried over or under, or across at a grade level or otherwise, as may be found most expedient for the public good."

"All railroad companies shall keep in good order, at their expense, the public roads or private ways established pursuant to law, where crossed by their several roads, and build suitable bridges and make proper excavations or embankments, according to the spirit of the road laws."

IDAHO.

Section 2671. No railroad corporation must use any street, alley, or highway, or any of the land or water, within any incorporated city or town, unless the right to so use the same is granted by a two-thirds vote of town or city authority from which the right must emanate.

Section 2672. Whenever the track of such railroad crosses a railroad or highway, such railroad or highway may be carried under, over, or on a level with the track as may be most expedient; and in cases where an embankment or cutting necessitates a change in the line of such railroad or highway, the corporation may take such additional lands and materials as are necessary for the construction of such road or highway on such new line.

If such other necessary lands cannot be had otherwise, they may be condemned as provided in the Code of Civil Procedure; and when compensation is made therefor, the same becomes the property of the corporation.

Section 2683. A bell, of at least 20 pounds' weight, must be placed on each locomotive engine, and be rung at a distance of at least 80 rods from the place where the railroad crosses any street, road, or highway, and be kept ringing until it has crossed such street, road, or highway; or a steam whistle must be attached, and be sounded, except in cities, at the like distance, and be kept sounding at intervals until it has crossed the same, under a penalty of $100 for every neglect, to be paid by the corporation operating the railroad, which may be recovered in an action prosecuted by the district attorney of the proper county, for the use of the state. The corporation is also liable for all damages sustained by any person, and caused by its locomotives, trains, or cars, when the provisions of this section are not complied with.

ILLINOIS.

62. Fencing Track.—Every railroad corporation shall, within six months after any part of its line is open for use, erect and thereafter maintain fences on both sides of its road or so much thereof as is open for use, suitable and sufficient to prevent cattle, horses, sheep, hogs or other stock from getting on such railroad, except at the crossings of public roads and highways, and within such portion of cities and incorporated towns and villages as are or may be hereafter laid out and platted into lots and blocks, with gates or bars at the farm crossings of such railroad, which farm crossings shall be constructed by such corporation when and where the same may become necessary, for the use of the proprietors of the lands adjoining such railroad; and shall also construct, where the same has not already been done, and thereafter maintain at all road crossings now existing or hereafter established, cattle-guards suitable and sufficient to prevent cattle, horses, sheep, hogs and other stock from getting on such railroad; and when such fences or cattle-guards are not made as aforesaid, or when such fences or cattle-guards are not kept in good repair, such railroad corporations shall be liable for all damages which may be done by the agents, engines or cars of such corporation, to such cattle, horses, sheep, hogs or other stock thereon, and reasonable attorney's fees in any court wherein suit is brought for such damages, or to which same may be appealed; but where such fences and guards have been duly made and kept in good repair, such railroad corporation shall not be liable for any such damages, unless negligently or wilfully done.

67. Boards at Crossings.—Every railroad corporation shall cause boards, well supported by posts or otherwise, to be placed and constantly maintained upon each public road or street, where the same is crossed by its railroad on the same level. Said boards shall be elevated so as not to obstruct the travel, and to be easily seen by travelers. On each side of said boards shall be painted in capital letters, of at least the size of 9 inches each, the words "RAILROAD CROSSING," or "LOOK OUT FOR THE CARS." This section shall not apply to streets in cities or incorporated towns or villages, unless such railroad corporation shall be required to put up such boards by the corporate authorities of such cities, towns or villages; provided, that when warning boards have already been erected, under existing laws, the maintenance of the same shall be a sufficient compliance with the requirements of this section.

68. Bell and Whistle—Crossings.—Every railroad corporation shall cause a bell of at least 30 pounds' weight and a steam whistle placed and kept on each locomotive engine, and shall cause the same to be rung or whistled by the engineer or fireman, at the distance of at least 80 rods from the place where the railroad crosses or intersects any public highway, and shall be kept ringing or whistling until such highway is reached.

71. Approaches at Crossings.—Hereafter, at all of the railroad crossings of highways and streets in this state, the several railroad corporations in this state shall construct and maintain said crossings, and the approaches thereto, within their respective rights-of-way, so that at all times they shall be safe as to persons and property.

72. Neglect to Make, Etc., Crossing—Notice.—Whenever any railroad corporation shall neglect to construct and maintain any of its crossings and approaches, as provided in section 8 of this Act, it shall be the duty of the proper public authorities, having the charge of such highways or streets, to notify, in writing, the nearest agent of said

railroad corporation of the condition of said crossing or approaches, and direct the same to be constructed, altered or repaired in such manner as they shall deem necessary for the safety of persons and property.

76a. Two or More Railroads Crossing Each Other on Same Level—Requirements.—When and in case two or more railroads crossing each other at a common grade, or any railroad crossing any stream or harbor by swing or draw bridge, shall, by a system of interlocking and automatic signals, or by other works, fixtures and machinery to be erected by them, or either of them, render it safe for engines and trains to pass over such crossing or bridge without stopping, and such system of interlocking and signals, works or fixtures shall first be approved by the railroad and warehouse commissioners, or any two of them, and a plan of such interlocking and signals, works and fixtures for such crossing designating the plan of crossing shall have been filed with such railroad and warehouse commissioners, then, and in that case, it is hereby lawful for the engines and trains of any such railroad or railroads to pass over said crossing or bridge without stopping, any law, or the provisions of any law, now in force to the contrary notwithstanding; and all such other provisions of laws contrary thereto are hereby declared not to be applicable in such case; provided, that the said railroad and warehouse commissioners shall have power in case such interlocking system, in their judgment, shall by experience prove to be unsafe or impracticable to order the same to be discontinued.

76b. Civil Engineer to Examine System, Etc.—Compensation.—The said railroad and warehouse commissioners may appoint a competent civil engineer to examine such proposed system and plans, and report the result of such examination for the information of such railroad and warehouse commissioners; and said railroad and warehouse commissioners are hereby authorized to allow and reward $5 per day as a compensation for the services of such civil engineer, or such reasonable sum as such commissioners shall deem fit, and to allow and reward such other and further sums, as they shall deem fit to pay all other fees, costs and expenses to arise under said application, to be paid by the railroad company or companies in interest, to be taxed and paid or collected as in other cases. And the said railroad and warehouse commissioners are also empowered on application for their approval of any such system of interlocking and signals, works or fixtures, to require of the applicant security for such fees, costs and expenses, or the deposit, in lieu thereof, of a sufficient amount in money for that purpose to be fixed by them.

209. The Crossing of One Railroad by Another.—Hereafter any railroad company desiring to cross with its tracks the main line of another railroad company, shall construct the crossing at such place and in such manner as will not unnecessarily impede or endanger the travel or transportation upon the railway so crossed. If in any case objection be made to the place or mode of crossing proposed by the company desiring the same, either party may apply to the board of railroad and warehouse commissioners and it shall be their duty to view the ground and give all parties interested an opportunity to be heard. After full investigation, and with due regard to safety of life and property, said board shall give a decision prescribing the place where and the manner in which said crossing shall be made, but in all cases the compensation to be paid for property actually required for the crossing and all damages resulting therefrom, shall be determined in the manner provided by law in case the parties fail to agree.

210. Expense of Construction of Crossing.—The railroad company seeking the crossing shall in all cases bear the entire expense of the construction thereof, including all costs and incidental expenses in-

curred in the investigation by the board of railroad and warehouse commissioners.

211. Protecting Crossings—Interlocking or Other Safety Devices.—In every case where the main tracks of two or more railroads cross at a grade in this state, any company owning or operating any one of such tracks, whose managers may desire to unite with others by protecting such crossings with interlocking or other safety devices, may file with the railroad and warehouse commission a petition stating the facts of the situation, and asking said railroad and warehouse commission to order such crossing to be protected by interlocking signals, devices and switches, or other safety appliances. Said petition shall be accompanied by a plat showing the location of all tracks; and upon the filing thereof, notice shall be given to each other company or person owning or operating any track involved in such crossing, and the said railroad and warehouse commission shall thereupon view the site of such crossing, and shall, as soon as practicable, appoint a time and place for the hearing of such petition.

212. When Grade Crossing Dangerous—Power of Commission—Petition.—If the said railroad and warehouse commission shall, from information obtained in any manner, have cause to believe that any such grade crossing, as described in section 1 of this Act, is dangerous to the public or to persons operating trains, and requires protection, then it shall be the duty of said commission without any petition, and of its own motion, to cite the several companies or persons owning or operating the railway tracks forming such crossing, to come before said commission at such time and place as may be named, and show cause why they should not be required to provide such crossing with interlocking or other safety appliances.

213. Commission to Hear Petition—Interlocking Signals, Etc.—Cost.—At the time and place named for hearing under any petition filed in pursuance of section 1 of this Act, or in any citation issued in pursuance of section 2 thereof, unless the hearing is for good cause continued, said railroad and warehouse commission shall proceed to try the question whether or not the crossing shall be protected by interlocking or otherwise, and shall give to all companies and parties interested an opportunity to be fully heard, and said commission shall, after such hearing, enter an order upon a record book or docket to be kept for the purpose, denying the petition or discharging the citation if the protection of such crossing as proposed is deemed unnecessary, or if said commission shall be of opinion, from the evidence and facts produced, that the public good requires that such crossing be protected, then the commission shall enter an order prescribing an interlocking device or equipment for such crossing, in case the companies interested cannot agree upon a device, in which order shall be specified the kind of machine to be used, the switches, signals and other devices or appliances to be put in, and the location thereof, and all other matters which may be deemed proper for the efficient protection of such crossing, and said commission shall further designate, in such order, the proportion of the cost of the construction of such plant, and of the expense of maintaining and operating the same, which each of the companies or persons concerned shall pay. In case, however, one railroad company shall hereafter seek to cross at grade with its track or tracks, the track or tracks of another railroad company, and the railroad and warehouse commission shall determine that interlocking or other safety appliances shall be put in, the railroad company seeking to cross at grade shall be compelled to pay all cost of such appliances, together with the expense of putting them in and the future maintenance thereof.

214. Commission to Inspect Plant—May Issue Permit to Run Crossing Without Stopping.—It shall be the duty of every railroad company or person owning or operating any track involved in any such crossing to comply with and carry out fully, or unite with the others in doing so, any order of said railroad and warehouse commission made in pursuance of any proceeding instituted or had under this Act, such work to be completed within 90 days after such order is made, unless the railroad and warehouse commission shall for good cause shown extend the time; and when any such plant shall have been completed and made ready for use, it shall be the duty of the companies or persons concerned to notify the said railroad and warehouse commission thereof, whereupon said commission shall inspect or cause to be inspected the said completed plant in the same manner as is now provided in the Act upon that subject, approved June 3, 1887; and if, upon such inspection the said plant is deemed to be well constructed and suitable and sufficient for the purpose, the said railroad and warehouse commission shall issue a permit empowering the several companies or persons owning or operating the tracks involved herein to run such crossing without stopping, under such rules and regulations as may be in force, or may thereafter be adopted, by the said commission, any law now in force upon the subject of stopping trains at railway crossings to the contrary notwithstanding.

215. Penalty for Not Complying with Order.—Any company, person or corporation refusing or neglecting to comply with any order made by the said railroad and warehouse commission in pursuance of this Act shall forfeit and pay a penalty of $200 for each week of such refusal and neglect, the same to be recovered in an action of debt in the name of the people of the State of Illinois, and to be paid, when collected, into the county treasury of any county where any such suit may be tried.

216. Expenses—How Paid.—All expenses incurred in any proceeding under this Act shall be paid by the railway companies concerned, in equal portions, upon bills to be rendered by the secretary of said commission.

217. What a Crossing Within Meaning of Act.—Every junction of two or more railroad tracks, whether the tracks joining each other are owned by different companies or by the same company, shall be taken and deemed to be a crossing within the meaning of this Act: provided, that this section shall not apply to a switch, spur or side tracks.

INDIANA.

Section 20. Crossings of Railroads—Grade.—Where it becomes necessary for the track of one railroad company to cross the track of another railroad company, unless the manner of making such crossings shall be agreed to between such companies, it shall be the duty of the Circuit Court of the county wherein such crossing is located, of the judge thereof in vacation, to ascertain and define by its decree the mode of such crossing which will inflict the least practicable injury upon the rights of the company owning the road which is intended to be crossed; and if in the judgment of such court it is reasonable and practicable to avoid a grade crossing, it shall by its process prevent a crossing at grade.

Section 30. Grading Crossings in Town or City.—It shall be the duty of each railroad company whose road or track cross, or shall hereafter cross, any street, avenue or alley in any incorporated town or city in the State of Indiana, which said street, avenue or alley has been,

or shall hereafter be, by addition, plat or otherwise, dedicated to the public use, to properly grade and plank or gravel its road and tracks at its intersection with the crossing of said street, avenue or alley in accordance with the grade of said street or avenue, in such manner as to afford security for life and property at said intersection and crossing.

Section 34. Town or City May Grade Crossings and Sue Railroad.—Should any such railroad company fail or neglect to comply with the provisions of section 1 of this Act within the time prescribed in the notice hereinbefore provided for, then said town or city may have said work done at said crossing and intersection in the manner prescribed in said section, and recover the amount of the cost and expenses thereof, including reasonable attorney fees, from said railroad company by suit in any court of competent jurisdiction.

Section 49. Crossing Roads.—Whenever the track of such railroad shall cross a road or highway, such road or highway may be carried under or over the track, as may be most expedient; and in cases where an embankment or cutting shall make a change in the line of such road or highway desirable, with a view to a more easy ascent or descent, the said company may take such additional lands for the construction of such road or highway, or such new line, as may be deemed requisite by said directors. Unless the lands so taken shall be purchased or voluntarily given for the purposes aforesaid, compensation therefor shall be ascertained in the manner in this Act provided, as nearly as may be, and duly made by such corporation to the owners and persons interested in such lands; and the same, when so taken and compensation made, shall become part of such intersecting road or highway, in such manner and by such terms as the adjacent parts of such highway may be held for highway purposes.

Section 50. Flagman at Highway Crossing.—All railroads owned or operated in the state having more than two tracks across any public highway or road and used for switching purposes exclusively, or regularly, or if only one track and used for switching purposes, said railroad corporation shall, upon the order of the county commissioners in which said railroad is located, place a flagman at said crossing and maintain the same at their expense from 6 o'clock a. m. to 8 o'clock p. m., of each and every day, or so long as said commissioners deem it necessary.

Section 52. Lights at Street Crossings.—The common councils of all cities of this state, not working under a special charter granted by the Legislature of the State of Indiana, shall have power to provide by ordinance or resolution for the security and safety of citizens and other persons from the running of trains through any city by requiring railroad companies running and operating a railroad though any city to keep and maintain lights on all nights that the common council may direct, at the points where the railroad tracks cross a street in any city, and may in such ordinance or resolution provide what kind of lights the railroad company shall maintain, and the manner of enforcing the compliance with the said resolution or ordinance by the railroad company, and for that purpose shall have power to pass and enforce a penal ordinance; provided, that no city shall have authority under this Act to pass any resolution or ordinance requiring any railroad company to maintain any different kinds of lights than that maintained by said city.

Section 184. Signals at Crossings.—It shall be the duty of all railroad companies operating in this state to have attached to each and every locomotive engine a whistle and a bell, such as are now in use

or may be hereafter used by all well-managed railroad companies; and the engineer or other person in charge of or operating such engine upon the line of any such railroad shall, when such engine approaches the crossing of any turnpike or other public highway in this state, and when such engine is not less than 80 nor more than 100 rods from such crossing, sound the whistle on such engine distinctly three times and ring the bell attached to such engine continuously from the time of sounding such whistle until such engine shall have fully passed such crossing; provided, that nothing herein shall be so construed as to interfere with any ordinance that has been or may hereafter be passed by any city or incorporated town in this state regulating the management or running of such engines or railroads within the limits of such city or incorporated town.

Section 201. Gates at Farm Crossings.—All gates and bars at farm crossings shall, in the absence of a contract or agreement to the contrary, be constructed and maintained and kept closed by the owner of such farm crossing.

Section 202. Driveways to Connect Lands.—Owners of tracts of land separated by the right-of-way of a railroad company may, if such right-of-way has been or shall hereafter be acquired by condemnation and appropriation, construct and maintain wagon and driveways over and across such right-of-way leading from one of such tracts to another on the opposite side of such right-of-way at any point most convenient to such owner. For this purpose such owner may enter upon such right-of-way and construct such embankment or make such excavation on both sides of the track of such railroad as may be necessary to establish easy grades from one tract of land to the opposite, and may spike planks on the ties of such railroad on the line of such way for the space of the width of such ways, of such thickness as not to be elevated above the tops of the rails of such railroads, and may also bridge the gutters at the side of such railroad track in such manner as not to obstruct the flow of water therein. (R. S. 1897, 5484; R. S. 1894, 5320.)

IOWA.

Section 2017. Raising or Lowering Highways.—Any such corporation may raise or lower any turnpike, plank road or other road for the purpose of having its railway cross over or under the same, and in such cases said corporation shall put such road, as soon as may be, in as good repair and condition as before such alteration.

[This section as it originally stood, authorizing a railway corporation to raise or lower a highway "for the purpose of having its railway pass over or under the same," was construed to confer upon railway companies the right to construct their tracks upon the public highways, including the streets of a city, without compensation to an abutting property owner, where he did not own the fee in the highway or street—But as now amended, by substituting "cross" for "pass," it cannot be construed as authorizing such use of highways or streets without other express legislative authority—The obligation imposed by the statute upon a railway company constructing and operating its railway, to construct at all points where the highway crosses it sufficient and safe crossings, is binding upon all corporations using railways in the state—The embankment constructed as necessary approach to the crossing is a part of the crossing and the company is required to keep it in repair—The company is bound to keep crossings in a safe condition, and this obligation extends to the approaches to a bridge—The company

is under obligation to build and keep in repair an overhead crossing and the approaches thereto, provided the grade crossing is unsuitable and the overhead crossing is necessary to put the street in proximately as good repair and condition as before the railroad was built.]

Section 2022. Private Crossings.—When any person owns land on both sides of any railway, the corporation owning the same shall, when requested so to do, make and keep in good repair one cattle-guard and one causeway or other adequate means of crossing the same, at such reasonable place as may be designated by the owner.

Section 2054. Cattle-guards—Crossings—Signs.—Every corporation constructing or operating a railway shall make proper cattle-guards where the same enters or leaves any improved or fenced land, and construct at all points where such railway crosses any public road good, sufficient, and safe crossings and cattle-guards, and erect at such points, at a sufficient elevation from such road as to admit of free passage of vehicles of every kind, a sign with large and distinct letters placed thereon, to give notice of the proximity of the railway, and warn persons of the necessity of looking out for trains. Any railway company neglecting or refusing to comply with the provisions of this section shall be liable for all damages sustained by reason of such refusal or neglect, and it shall only be necessary, in order to recover, for the injured party to prove such neglect or refusal.

Section 2072. Signals at Road Crossings.—A bell and a steam whistle shall be placed on each locomotive engine operated on any railway, which whistle shall be twice sharply sounded at least 60 rods before a road crossing is reached, and after the sounding of the whistle the bell shall be rung continuously until the crossing is passed; but at street crossings within the limits of cities or towns the sounding of the whistle may be omitted, unless required by ordinance or resolution of the council thereof; and the company shall be liable for all damages which shall be sustained by any person by reason of such neglect. Any officer or employe of any railway company violating any of the provisions of this section shall be punished by a fine not exceeding $100 for each offense.

KANSAS.

Signboards at Crossings.—Every railway corporatioon shall cause boards to be placed, well supported by posts or otherwise, and constantly maintained, across each traveled public road or street when the same is crossed by the railway on the same level. Said boards shall be elevated so as not to obstruct the travel, and to be easily seen by travelers, and on each side of such board shall be painted in capital letters: "Look Out for the Cars." But this section shall not apply to streets in cities or towns, unless the corporation shall be required to put up such boards by the city or town authorities, or the officer having charge of such streets.

Cattle-guards and Railway Crossings.—When any railroad runs through any improved or fenced land, said railroad company shall make proper cattle-guards on such railroad when they enter and when they leave such improved or fenced land.

Any railroad company neglecting or refusing to comply with the provisions of section 1 of this Act (or the preceding section) shall be liable for all damages sustained by anyone by reason of such neglect and refusal, and in order for the injured party to recover all damages he has sustained it shall only be necessary for him to prove such neglect or refusal.

Railroads in this state shall be liable for all damages done to person or property when done in consequence of any neglect on the part of the railroad companies.

Any judgment recovered against any railroad company in this state for any injury to persons or property shall be a lien within the county, when recovered, on the railroad and real or other property of such company, and shall be prior and superior to the lien of any mortgage or trust deed which may be thereafter executed, except liens for taxes.

Crossings of Public Highways.—It shall be the duty of each and every railway company or corporation owning, controlling or operating any line of railroad within this state to construct and keep in repair at each crossing of any regularly laid out public highway a good and substantial crossing, by securing on each side of each rail a board not less than 12 feet long, and not less than 10 inches wide and two inches thick, and shall fill the space between the two inside boards with gravel or broken stones, or shall floor the space with boards not less than two inches thick and 12 feet long.

Steam Whistle to Be Sounded—Penalty.—A steam whistle shall be attached to each locomotive engine, and shall be sounded three times, at least 80 rods from the place where the railroad shall cross any public road or street, except in cities and villages, under a penalty of not more than $20 for every neglect of the provisions of this section, to be paid by the corporation owning the railway, on the suit of the county attorney, to go to the county for the support of common schools; and the corporation shall also be liable for all damages which shall be sustained by any person by reason of such neglect; provided, however, that such penalty shall be sued for within one month from the time the cause of action accrues, and not thereafter; and provided, further, that but one penalty shall be recovered in any one action.

(Farm crossings, flagmen at crossings in towns and cities, lighting of city crossings by railroad companies and gradual abolition of grade crossings are not provided for by our statutes.)

KENTUCKY.

Railroad companies are required to erect signal boards, well supported by posts or otherwise, at such heights as to be easily seen by travelers, and not obstructing travel, containing on each side, in capital letters at least five inches in height, the following inscription: "Railroad Crossing," to be placed and maintained at each public highway where it is crossed by the railroad at the same level; but such board need not be put up in cities or towns, unless required by the local authorities thereof.

Whenever in the opinion of the railroad commission the public interest requires that a gate be erected or maintained or a flagman stationed at any highway crossing within one mile of the corporate limits of any incorporated city or town, they shall serve written notice on the corporation to erect and maintain at such crossing the character of gate directed by the commission, and keep a man in charge of the same during such hours as they may designate, or keep a flagman at such crossing during such hours as they may require. The railroad commission may authorize the discontinuance of such gate or flagman whenever in their judgment the public interest no longer requires the same.

Any corporation or person owning or controlling a railroad in this commonwealth, owning right-of-way, and its railroad shall have been constructed and in operation for the period of five years, the same is put on equal terms and obligations with other landowners adjoining lands in this commonwealth, and are required to erect and maintain fences along their right-of-way.

Every such corporation or person owning or controlling and operating a railroad in this commonwealth, and owning right-of-way, shall construct

and maintain a good and lawful fence on one-half of the distance of the division line between such rights-of-way and the adjoining lands, and that every owner of land or lands adjoining any rights-of-way of such corporation shall construct and maintain a good and lawful fence on one-half of the distance of the division line between such land or lands and such right-of-way.

The provisions of this act shall not apply in cases where corporations or persons owning or controlling and operating a railroad have furnished material to construct a fence or condemned its right-of-way and paid the owner or his vendor damages, in the estimation of which the cost of fencing was taken into consideration, nor be so construed as to require such corporation or person as aforesaid to build any fence along the line through any town or city or across any public or private highway; nor shall such corporation be required to construct such fences through unimproved and uncultivated lands until the owner of such lands shall have previously enclosed said lands on three sides with sufficient fences, or unless such lands be enclosed with fences and a river, creek, bluff, or such other natural barrier as will prevent the egress of stock.

Cattle-guards are required to be maintained at all terminal points of fences constructed along the lines of railroads, except at such points where such lines are not required to be fenced on both sides, and at public crossings. Where there is a private passway across said railroad, the landowner for whose benefit it is kept shall bear one-half the expense of cattle-guards and gates, the former to erect the gates, the corporation to erect the cattle-guards.

LOUISIANA.

Where railroads cross highways, the corporation must so construct the work as not to hinder, impede, or obstruct its safe and convenient use; and where railroads are constructed or dug across plantations or land in cultivation, or that may be cultivated, the corporation must so construct the work as not to hinder, impede, or obstruct the drainage of the land. Where railroads cross tidewaters or navigable streams or rivers, the company may erect for the sole and exclusive use of such railroad the bridges required for the crossing, but such bridges shall be so constructed as not to obstruct or necessarily impede navigation.

There is no responsibility on the part of railroad companies for the killing or injury of stock where railroad companies have their line of track fenced in and kept in good repair, and have erected and maintained in good order suitable cattle-guards at crossings.

MAINE.

Chapter 51, Section 21. Cattle-Guards.—The commissioners shall order the corporation to maintain such cattle-guards, cattle-passes and farm crossings as they think reasonable; prescribe the time and manner of making them, and consider the work in awarding pecuniary damages; and if the corporation, after 48 hours' notice in writing to its president or superintendent, neglects to commence the work or complete it within a reasonable time, the owner may apply to the Supreme Court, and the court, after due notice to said corporation, shall issue all necessary processes to enforce the specific performance of such orders, or restrain it by injunction; or the party interested may recover, in an action on the case, double the damage that he has sustained by such neglect.

Section 33. Bell, Whistle, Signboards, Etc.—A bell of the weight of 35 pounds or more shall be placed on each engine used on a railroad, and shall be rung at the distance of 85 rods or more from the crossing of a way on the same level, or running contiguous thereto, and kept ringing until the engine has passed the same; and a steam whistle, or, in cities and villages, a bell, shall be sounded as a warning at a distance of 100 rods; and boards with the words, "RAILROAD CROSSING," distinctly painted thereon, on each side, in letters plainly legible, shall be placed on the side of a way where it is crossed by a railroad, on a post or other structure, in such position as to be easily seen by persons passing upon such way.

Section 34. Gates, Flagmen.—When the municipal officers of a town deem it necessary for public safety that gates should be erected across a way where it is crossed by a railroad, and that a person should be appointed to open and close them, they may make such request in writing; and in case of neglect or refusal, they may apply to the county commissioners to decide upon the reasonableness of such request, who, after notice and hearing, shall decide. When they decide that such request is reasonable, or that at said crossing a flagman is necessary for the public safety, they may, upon said application, order a flagman to be stationed there, instead of gates, and the corporation shall comply with such order, and pay the costs; when they decide otherwise, the costs shall be paid by the applicants.

Section 27. Ways, Crossing Railroad Tracks, How Laid Out.—Town ways and highways may be laid out across, over, or under any railroad track, in the same manner as other town ways and highways, except that before such way shall be constructed, the railroad commissioners, on application of the municipal officers of the town or city wherein such way is located, or of the parties owning or operating the railroad, shall, upon notice and hearing, determine whether the way shall be permitted to cross such track at grade therewith, or not, and the manner and conditions of crossing the same, and the expense of building and maintaining so much thereof as is within the limits of such railroad shall be borne by such railroad company, or by the city or town within which such way is located, or shall be apportioned between such company and city or town, as may be determined by said railroad commissioners. Said commissioners shall make a report in writing of their decision thereupon, file the same in their office, and cause to be sent by mail or otherwise to each of the railroad corporations, and the municipal officers of the city or town as the case may be, interested therein, a copy of such decision. Such decision shall be final and binding upon all parties, unless an appeal therefrom is taken and entered to the next succeeding term of the supreme judicial court, to be held in the county where the crossing is located, more than 30 days after the filing of the report. The appellant shall, within 14 days after the filing of such report, file in the office of the railroad commissioners its reasons for appeal, and 14 days at least before the sitting of the Appellate Court it shall cause to be served upon such other interested corporations or municipality, a copy of such reasons for appeal, certified by the clerk of the board of railroad commissioners. The presiding justice, at such term of court, shall make such order or decree thereon, as law and justice may require. Exceptions may be taken to such order or decree. Costs may be taxed and allowed to either party at the discretion of the court.

Highways and other ways may be raised or lowered for the purpose of permitting a railroad to pass over or under the same, or the course of the same may be altered so as to facilitate any crossing,

or to permit a railroad to pass at the side thereof, on application to the railroad commissioners, and proceeding as provided for above, and for such purposes land may be taken and damages awarded as provided for laying out highways and other ways.

Section 28. Crossings of Highways and Streets, How Made, Etc.—Railroads may cross highways or town ways, in the line of the railroad, but cannot pass along them without leave of the town, but when a railroad is hereafter laid out across a highway or other public way, it shall be constructed so as to pass either over or under such way, unless the railroad commissioners, after notice and hearing, authorize a crossing at grade. Before entering upon the construction of any railroad, the manner and conditions of crossing shall be determined as provided by section 27. But no crossing of a street in a city, not a highway, shall be made without the written consent of the mayor and aldermen. Crossings not so made are nuisances, and may be so treated, and the directors of railroad corporations making them are personally liable.

MARYLAND

Railroad companies are required to place signboards at points where its tracks cross a highway.

There is no provision for the sounding of bell or whistle on approaching crossings, but the courts have held it is incumbent upon railroad companies to do so on approaching crossings.

When, in the opinion of the county commissioners, the public safety requires it, railroad companies may be required to erect suitable safety appliances at road crossings, either by a system of electric alarm bells, the placing of a flagman at crossings, or safety gates; or may require that the grade be changed so as to pass under or over the highway, in which case neither a flagman nor safety-gates shall be required.

MASSACHUSETTS.

Section 115. Every railroad corporation shall erect and maintain suitable fences with convenient bars, gates, or openings therein upon both sides of the entire length of its railroad, except at the crossings of a highway or other way or in places where the convenient use of the road would be thereby obstructed, and except at places where and so long as specially exempted from the duty of so doing by the county or railroad commissioners; and shall also construct and maintain sufficient barriers, where it is necessary and practicable to do so, to prevent the entrance of cattle upon the road. A corporation unreasonably neglecting to comply with the provisions of this and the following section, shall, for every such neglect, forfeit a sum not exceeding $200 for every month during which the neglect continues; and the supreme judicial court or a justice thereof, in term time or vacation, by injunction or other suitable process in equity, may compel the corporation to comply with such provisions, and upon such neglect, may restrain and prohibit it from crossing a highway or town way, or from using any land, until such provisions are complied with.

RAILROAD CROSSINGS—GENERAL PROVISIONS.

An Act Relating to Crossings of Railroads, Street Railways, Highways and Other Ways.—In any case in which the consent or approval of the board of railroad commissioners now is or hereafter may be

required by law for the crossing of a railroad by another railroad, street railway, highway or other way, or for the crossing of a highway or other way by a railroad, or street railway, or for any other crossing of or by a railroad, street railway, highway or other way, at grade, the said board after due notice and a hearing of the parties interested may, in case its consent or approval is given, impose such conditions, limitations, restrictions and regulations in respect to such crossing and the manner and use thereof, and may from time to time so change and modify the same, as, having primary regard to the public safety and convenience, said board may deem to be reasonable and necessary.

Section 119. Crossings of Railroads with Public Ways.—When a railroad is laid out across a highway or other way, it shall be constructed so as not to obstruct the same; and, unless the county commissioners and the board authorize a crossing at the same level as provided in section 123, it shall be constructed so as to pass either over or under the way, as prescribed in the following section, and conformably to any decree which may be made by the county commissioners under section 121.

Section 120. If the railroad is constructed to pass over the way, a sufficient space shall be left under the railroad conveniently to accommodate the travel on the way. If the railroad is constructed to pass under the way, the railroad corporation shall build such bridges, with their abutments, and suitable approaches thereto, as will accommodate the travel upon the way; but no bridge for any purpose shall be constructed over a railroad at a height less than 18 feet above the track of such railroad, except by the consent in writing of the board. The supreme judicial court may, by suitable process in equity, compel a compliance with the provisions of this section.

Section 121. A railroad corporation may raise or lower a highway or other way for the purpose of having its road pass over or under the same: but before proceeding to cross or to alter or excavate for the purpose of crossing the way, it shall obtain from the county commissioners a decree prescribing what alterations may be made in the way, and the manner and time of making the alterations or structures which the commissioners may require at the crossing; and before entering upon, excavating, or altering the way, shall give to the city or town in which the crossing is situated security, satisfactory to the commissioners, that it will faithfully comply with the requirements of the decree to their acceptance, and will indemnify the city or town against all damages and charges by reason of a failure so to do.

Section 122. A railroad corporation may alter the course of a highway or other way for the purpose of facilitating the crossing of the same by its road, or of permitting its road to pass at the side thereof without crossing, upon obtaining a decree of the county commissioners prescribing the manner and time of such alteration, if before granting the decree they, after due notice to the city or town in which the way is situated, decide that the alteration will not essentially injure the way. The corporation shall pay all damages occasioned to private property by the alteration, as in case of land taken for its road.

Section 123. When a railroad is laid out across a highway or other way, the county commissioners, upon the application of the railroad corporation or of the mayor and aldermen of the city or selectmen of the town in which the crossing is situated, after due notice to all persons interested and a hearing, may adjudge that public necessity requires the crossing at the same level, and may, if the board also consents in writing to such crossing at the same level, make a decree specially to authorize and require the corporation so to construct its road, in such manner as shall be prescribed in the decree; and said

commissioners may modify the terms of such decree, or may revoke the same, at any time before the construction of the railroad at such crossing.

Section 124. A railroad corporation, whose road is crossed by a highway or other way on a level therewith, shall at its own expense so guard or protect its rails by plank, timber, or otherwise as to secure a safe and easy passage across its road; and if in the opinion of the county commissioners any subsequent alteration of the highway or other way or additional safeguards are required at the crossing, they may order the corporation to establish the same as provided in section 121.

Section 125. A highway or town way may be laid out across a railroad previously constructed, when the county commissioners adjudge that the public convenience and necessity so require; and in such case, after due notice to the railroad corporation and hearing all parties interested, they may thus lay out or may authorize a city or town on petition of the mayor and aldermen or selectmen thereof to lay out a way across a railroad, in such manner as not to injure or obstruct the railroad, and otherwise in conformity with the provisions of sections 119 and 120; but not permitting it to cross at a level with the railroad unless public necessity so requires, and unless the board also consents thereto in writing, in which case the county commissioners may give special authority for such crossing as provided in section 123.

Section 126. A railroad corporation may, with the consent of a canal corporation, alter the course of a canal, or of a feeder to a canal, where the same interferes with the convenient location of its road. Damages caused by taking the property of a person under this section shall be estimated and paid as in case of land taken under section 95.

Section 127. The county commissioners, if upon application to them by the mayor and aldermen of a city or selectmen of a town, and after due notice to the corporation, it appears that a railroad corporation crosses with its road a highway or other way therein so as to obstruct the same, contrary to the provisions of section 119 or of a decree made under section 121, or that it refuses or neglects to keep in proper repair a bridge or other structure required or necessary at such crossing, may pass a decree prescribing what repairs shall be made by the corporation at the crossing, and the time within which they shall be made, and shall order the corporation to pay the costs of the application. They may further order the corporation to give security, as provided in section 121, for the faithful performance of the requirements of the decree, and for the indemnity of said city or town upon a failure in such performance.

Section 128. Every railroad corporation shall, at its own expense, construct, maintain, and keep in repair all bridges, with their approaches and abutments, which it is authorized or required to construct over or under a canal, highway, or other way; and a city or town may recover of the railroad corporation whose road crosses a highway or town way therein, all damages, charges, and expenses incurred by such city or town by reason of the neglect or refusal of the corporation to erect or keep in repair all structures required or necessary at such crossing; but if, after the laying out and making of a railroad, the county commissioners authorize a highway or other way to be laid out across the railroad, all expenses of and incident to constructing and maintaining the way at such crossing shall be borne by the county, city, town, or other owner of the same, until or unless in either case it is otherwise determined by an award of a special commission, as provided in the five following sections.

Section 129. Alteration of Crossings.—If a highway or town way and a railroad cross each other, and the mayor and aldermen of the city or the selectmen of the town in which the crossing is, or the directors of the railroad corporation, are of the opinion that it is necessary for the security or convenience of the public that an alteration should be made in the crossing, the approaches thereto, the location of the railroad, highway, or town way, or in a bridge at the crossing, the county commissioners shall, after due notice, hear all parties interested, and, if they decide that such alteration is necessary, shall prescribe the manner and limits within which it shall be made, and shall forthwith certify their decision in the matter to the parties, and also to the board.

Section 130. If the county commissioners decide that the location of the railroad, or of the highway or town way, shall be changed, land or other property may be taken therefor according to the provisions of law authorizing the taking of land by railroad corporations, or for highways or town ways, as the case may be; and all damages occasioned by such taking or otherwise shall be assessed in the manner provided in case of the taking of land by railroad corporations, or for highways and town ways, respectively.

Section 131. A special commission of three disinterested persons, to be appointed as provided in the following section, shall determine which party shall carry such decision into effect, and which party shall pay the charges and expenses of making such alteration, and all future charges for keeping such crossing and the approaches thereto in repair, as well as the costs of the application to the county commissioners, and of the hearing before said special commission; and it may apportion all such charges, expenses and costs between the railroad corporation and the towns, cities or counties in which said crossing is situated and other towns and cities specially interested in the matter; provided, that the county may be omitted from such apportionment, if such omission seems just, and any town or city except that in which the crossing is situated may also be omitted from the apportionment if it seems just so to do.

Section 132. The Superior Court or a justice thereof, in term time or vacation, upon the application of the county commissioners, the mayor and aldermen, the selectmen, or the directors of the railroad corporation, for the appointment of such commission, shall cause notice thereof to be given to the other parties interested 14 days at least before the time fixed for the hearing; and thereupon, after a hearing, shall appoint such commission, one member of which shall be a member of and designated by the board. The special commission shall meet as soon as may be after its members receive their appointments, and, after notice to and hearing the parties, shall make its award in writing, and return the same into said court.

Section 133. A party aggrieved by said award may, within 14 days after the same is so returned, apply to the court for a jury to revise and determine any matter of fact found therein; and thereupon the court shall order a trial by jury to be had at the bar of the court, after due notice to all parties interested in the matter of said award, in the same manner in which civil cases are tried by jury. The decree of the court upon said award or upon the verdict of a jury shall be final and binding, and said court shall have jurisdiction in equity to compel compliance therewith, and may also issue and enforce such interlocutory decrees and orders as justice may require.

Section 134. The party designated for that duty, having carried into effect the decision of the county commissioners, may recover of any other party in an action of contract the proportion awarded to be

paid by such other party, with interest; and if the party so designated unreasonably neglects or refuses to carry the decision into effect, any other party affected by such neglect or refusal may proceed to do it, and may recover from each or all of the others in an action of tort the proportion awarded to be paid by them respectively, and from the party so neglecting or refusing all charges, expenses and costs occasioned thereby.

ABOLITION OF GRADE CROSSINGS.

Section 1. An Act to Promote the Abolition of Grade Crossings by Railroads and Highways.—The jurisdiction given by section 129 of chapter 112 of the Public Statutes to county commissioners upon petition, may also, for the separation of grades at any level crossing of a railroad with a highway or town way, be assumed and exercised by them on the petition in writing signed by not less than 20 legal voters of the county wherein such crossing is situated; provided, that before final action there shall be a hearing, of which 30 days' notice shall be given to each town, city and railroad company interested, and published not less than two weeks in some newspaper in the county; provided, that the power conferred upon the county commissioners by this section shall not be exercised unless they adjudge and certify that in their opinion the cost of the proposed change will not exceed $3,000; and provided, that the order of the county commissioners, made under the additional power hereby conferred, shall not be carried into effect if it shall be made to appear to the special commission provided for by section 132 that the cost of the change will exceed the sum of $6,000. And if it be so made to appear, such special commission shall annul the order of the commissioners for said change. If said order is so annulled, the cost of the hearing by the special commissioners, taxed by them and approved by the district attorney, shall be paid by the county.

Section 2. The board of railroad commissioners shall have jurisdiction of cases arising in the city of Boston under section 129 of chapter 112 of the Public Statutes, either on petition by the mayor and aldermen of said city or the directors of the railroad company interested; and such directors are hereby authorized to petition in such cases.

Section 6. No appeal shall hereafter be allowed from any decision or order of the county commissioners directing a separation of grade under section 129 of chapter 112 of the Public Statutes; provided, that this section shall not apply to any proceedings pending when this Act takes effect.

Section 1. An Act to Promote the Abolition of Grade Crossings.—Upon petition of the mayor and aldermen of a city, or of the selectmen of a town, in which a public way and a railroad cross each other at grade, or of the directors of the railroad company, or of the attorney-general of the commonwealth upon instructions from the governor and council given after notice to parties interested and hearing thereon, setting forth that the petitioners are of the opinion that it is necessary for the security and convenience of the public that an alteration should be made in such crossing, in the approaches thereto, in the location of the railroad or public way, or in the grades thereof so as to avoid a crossing at grade, or that such crossing should be discontinued with or without building a new way in substitution therefor—the Superior Court or any justice thereof sitting in equity for the county in which such crossing or a portion thereof is situated, after such notice by public advertisement or otherwise as the court shall deem desirable, and a hearing, may in its discretion appoint a commission of three disinterested persons.

Section 2. A petition under the preceding section may embrace several crossings, or several railroads crossing at or near the same point; or, by order of the court, several separate petitions may be consolidated and heard as one.

Section 3. The members of the said commission shall meet as soon as may be after receiving notice of their appointment; and if, after due notice and hearing, the commission decide that the alterations are necessary for the security and convenience of the public, it shall prescribe the manner and limits within which such alterations shall be made, and shall determine which party shall do the work, or shall apportion the work to be done between the railroad companies and the city or town. The railroad companies shall pay 65 per centum of the total actual cost of the alterations, including in such cost the cost of the hearing and the compensation of the commissioners and auditors for their services, and all damages, including those mentioned in section 5 of this Act; and the said commission shall apportion the remaining 35 per centum of said cost between the commonwealth and the city or town in which the crossing or crossings are situated; provided, however, that not more than 10 per centum of such cost shall be apportioned to such city or town; provided, further, that the commonwealth shall not be charged any part of the expenses of abolishing grade crossings which are established after the passage of this Act.

Section 4. If the commission decide that any portion of an existing public way should be discontinued, it shall so specify; and it shall further specify the grades for the railroad and the public way or ways, and the general method of construction, and also what land or other property it deems necessary to be taken; provided, however, that if such decision involves a change in the grade of the railroad, the consent of the railroad commissioners to such change of grade shall first be obtained. Said commission shall forthwith return said decision into the said Superior Court. The decree of the court confirming the decision of the commission shall be final and binding. If the commission decides that the location of the railroad or of the public way shall be changed, the decree of the court confirming such decision shall constitute a taking of the specified land or other property; and it shall be the duty of the clerk of said court, within 30 days after the making of said decree, to cause a copy of such decision and decree to be filed with the county commissioners of the county or counties in which the land or other property taken and the crossing are situated, and also to be recorded in the registry of deeds for the counties and districts in which such land, property and crossings are situated, and also to be filed with the auditor of the commonwealth. Said taking shall be deemed to be a taking by the city or town if the land is to be used for a public way, or by the railroad company if the land is to be used by the railroad.

Section 5. All damages sustained by any person in his property by the taking of land for, or by the alterations of the grade of, a public way, or by an abutter thereon, for the discontinuance of such public way, to the same extent as damages are now recoverable by law by abutters on ways discontinued by towns, shall primarily be paid by the city or town; and all damages occasioned by the taking of land for the railroad shall primarily be paid by the railroad company; and in case the parties interested cannot agree upon said damages, the city, town, railroad company or other party may have the damages determined by a jury at the bar of the Superior Court for the county wherein the property and crossing are situated, on petition, brought within one year after the day of the date of the decree of the court confirming the

decision of said commission, by either of said parties, in the same manner and under like rules of law as damages may be determined when occasioned by the taking of land for the locating and laying out of railroads and public ways, respectively, in such city or town.

Section 6. After the completion of the work, the crossing and its approaches shall be maintained and kept in repair as follows: When the public way crosses the railroad by an overhead bridge, the framework of the bridge and its abutments shall be maintained and kept in repair by the railroad company; and the surface of the bridge and its approaches shall be maintained and kept in repair by the town or city in which the same are situated. When the public way passes under the railroad, the bridge and its abutments shall be maintained and kept in repair by the railroad company; and the public way and its approaches shall be maintained and kept in repair by the town or city in which they are situated.

Section 7. The court shall appoint an auditor, who shall be a disinterested person, not an inhabitant of the city or town in which the crossing is situated, to whom shall from time to time be submitted all accounts of expense, whether incurred by the railroads, city, town, commission or auditor, who shall audit the same and make report thereon to the court; which auditing, when accepted by the court, shall be final. A certified copy of such report and the decree of the court thereon shall in all cases be filed with the auditor of accounts. The compensation of the auditor shall be determined in accordance with the provisions of law relative to the compensation of auditors appointed by the Superior Court in civil cases. Said court shall from time to time issue its decrees for payment on the part of the railroad corporation, not exceeding the amounts apportioned to it by said auditor, and for the payment on the part of the commonwealth, not exceeding the amounts apportioned to the commonwealth and to the city or town; and such city or town shall repay to the commonwealth the amount apportioned to the city or town by said auditor, with interest thereon payable annually at the rate of 4 per cent. per annum from the date of the acceptance of the report of the auditor. Such repayment of the principal shall be made annually in such amounts as the auditor of the commonwealth may designate; and the amount of payment designated for the year, with the interest due on the outstanding principal, shall be included by the treasurer and receiver-general in, and made a part of, the sum charged to such city or town, and be assessed upon it in the apportionment and assessment of its annual state tax; and said treasurer shall in each year notify such city or town of the amount of such assessment, which amount shall be paid by the city or town into the treasury of the commonwealth at the time required for the payment and as a part of its state tax; provided, however, that when the last and final assessment, assessed as above on cities and towns, becomes due and is paid, the treasurer of the commonwealth shall pay to said cities and towns so paying, as an offset to and a reduction of such last payment, an amount equal to the excess, if any, of the amount of interest already assessed and collected from cities and towns under this section, above the actual interest cost to the commonwealth for money borrowed for the abolition of grade crossings previous to the payment of said last assessment by the cities and towns as aforesaid; and said excess of interest, if any, so paid shall be on the exact amounts repaid to the commonwealth by cities and towns on which interest has been collected under the provisions of this Act, and no more.

Section 8. The Superior Court, or any justice thereof sitting in equity in any county, shall have jurisdiction to compel compliance with

this act, and with the decrees, agreements and decisions made thereunder, and may issue and enforce such interlocutory decrees and orders as justice may require; and it shall be the duty of the attorney-general or his assistants to appear and represent the commonwealth in all suits and proceedings arising under this Act. Service of the petition and all notices or processes may be made upon the commonwealth by leaving an attested copy in the hands or in the office of the attorney-general.

Section 9. If the board of aldermen of a city or the selectmen of a town, in which a public way and a railroad cross each other, and the board of directors of the railroad company are of opinion that it is necessary for the security and convenience of the public that alterations should be made in such crossing, in the approaches thereto, in the location of the railroad or public way, or in the grades thereof, or in a bridge at such crossing, or that such crossing should be discontinued with or without building a new way in substitution therefor, and if they agree as to the alterations which should be made, an instrument in writing, signed in behalf of a city by the mayor on being thereto duly authorized by the board of aldermen, or in behalf of a town by the chairman of the selectmen on being thereto duly authorized by the board of selectmen, and by the president of the railroad company on being thereto duly authorized by its board of directors, specifying the manner and limits within which the alterations shall be made and by which party the work shall be done, or how it shall be apportioned between the city or town and the railroad company, the general method of construction, the grades for the railroad and the public way or ways, and also what land or other property it is necessary to take, and what portion, if any, of an existing public way is to be discontinued, and how the cost thereof shall be apportioned between the city or town and the railroad company, shall be valid and binding on the city or town and the railroad company respectively, and have the same force and effect as a decree of the court under the provisions of this Act; provided, that the board of railroad commissioners, after notice to all parties interested by advertisement and a public hearing, approve of the alterations set forth in the agreement as necessary for the convenience and security of the public. Said approval by the board shall constitute a taking of the land and other property specified in the agreement as necessary to be taken, and it shall be the duty of the clerk of said board, within 30 days after such approval, to cause a copy of the agreement and approval to be filed with the county commissioners of the county or counties in which the land or other property taken and the crossing are situated, and also to be recorded in the registry of deeds for the counties and districts in which such land, property and crossing are situated, and also to be filed with the auditor of the commonwealth. The provisions contained in this Act relating to the taking of land under a decree of the court, and in relation to the recovery of damages sustained by any person in consequence of such taking or of the alterations made in pursuance of said decree, shall apply to the taking of land and damages sustained under an agreement between the city or town and the railroad company made as herein provided, except that the petition for the determination of damages may be brought within one year after the date of the approval of such agreement by the board of railroad commissioners. After the completion of the work, the crossing and approaches shall be maintained and kept in repair as provided in section 6 of this Act. If the agreement provides for the abolition of a public grade crossing, it shall be the duty of the board of railroad commissioners to keep itself informed of the progress and character of the work, and the amounts reasonably

expended for work done or for damages, so far as rendered necessary for the abolition of the grade crossing; and for that purpose it may employ any necessary agents, and from time to time, as it may deem proper, shall issue certified statements of the amount legally and properly expended for such abolition of a grade crossing; and the commonwealth shall pay to the parties entitled thereto under the agreement 20 per centum of such expenditure.

Section 10. The amount to be paid under the provisions of this Act by the commonwealth in any one year (the year beginning with the passage of this Act) shall not exceed $500,000, and the total amount to be paid by the commonwealth under the provisions of this Act shall not exceed $5,000,000; provided, that if in any year the expenditure by the commonwealth under the provisions of this Act shall not amount to $500,000, the unexpended balance thereof shall be added to the $500,000 allowed to be paid by the commonwealth during any subsequent year; and the treasurer and receiver-general of the commonwealth shall pay the amount of cost allotted to the state from any money not otherwise appropriated, and is hereby authorized, when requested by the governor and council so to do, to issue and sell bonds from time to time, under such terms and conditions, and with a sinking fund for their redemption, as shall best promote the welfare of the commonwealth.

Section 2. The difference between the amounts heretofore annually paid and the $500,000 allowed to be annually paid by the commonwealth under the provisions of section 10 of chapter 428 of the Acts of the year 1890, may be paid at any time by the commonwealth under the provisions of said Act, in addition to the amounts already allowed to be expended.

Section 3. The estimates of the amounts to be paid, and the computation of the amounts paid by the commonwealth under the provisions of said chapter 428, shall not include the sums apportioned to cities and towns and advanced by the commonwealth under the provisions of section 7 of said chapter 428, as amended.

Section 11. Notice shall be filed by the petitioners with the railroad commissioners of the entry of any petition under the provisions of this Act; and, in case application shall be made for changes in grade crossings which will require, in the opinion of said commissioners after an examination of the decision of the commission appointed by the court, a larger expenditure in any one year on the part of the commonwealth than the amount provided for by this Act, said railroad commissioners shall have full power to decide which, if any, of said pending petitions shall be proceeded with during the year; and no decree shall be entered under any such petition until a certificate is filed thereon by the railroad commissioners that, in their judgment, the expenditure on the part of the commonwealth will not exceed the amount provided for by this Act.

Section 12. The provisions of sections 129 to 136, inclusive, of chapter 112 of the Public Statutes; chapter 135 of the Acts of the year 1882; chapter 194 of the Acts of the year 1885; and chapter 295 of the Acts of the year 1887, so far as they relate to proceedings for the abolition of grade crossings, shall not apply to the provisions of this Act; provided, however, that nothing in this Act shall have effect upon cases pending, or upon any right accrued, at the time of its passage.

Section 2. An Act to Amend an Act to Promote the Abolition of Grade Crossings.—The commissioners appointed under section 1 of said chapter 428 shall have the same jurisdiction, duties and powers where several railroads cross a public way at or near the same point,

as is now provided in said chapter where there is but one railroad; and they may apportion the work to be done among the companies owning said railroads, and shall equitably apportion the 65 per centum of the actual cost of the alterations the railroad companies are to pay under said chapter among the several companies owning said railroads so crossing said way; and they shall also apportion and award in what manner and proportion each of said railroad companies shall maintain and keep in repair the framework of the bridge and its abutments when the public way crosses the railroad by an overhead bridge, and the bridge and its abutments when the public way passes under said railroads, according to the provisions and limitations of section 6 of said chapter.

Section 3. This Act shall include in its application pending cases, and shall take effect upon its passage.

Section 1. An Act to Authorize Cities and Towns to Incur Indebtedness for the Purpose of Paying Damages Occasioned by the Taking of Land for the Alteration of Grade Crossings.—Any city or town required to pay primarily any land damages under the provisions of chapter 428 of the Acts of the year 1890, or any proportion of the general expense of altering a crossing under the provisions of said Act, may, in the case of a city by vote of the city council, and in the case of a town by ordinary vote at a legal town meeting called for the purpose, incur debts for temporary loans to pay such damages or expense, without regard to the general laws in force regulating and limiting municipal indebtedness and the manner and form of voting thereon; and when any money so primarily paid by a city or town is repaid to it, said money shall immediately be applied to payment of the loan.

Section 1. An Act Relative to a Loan for the Promotion of the Abolition of Grade Crossings, and a Sinking Fund Therefor.—Upon issuing any bonds authorized by chapter 428 of the Acts of the year 1890, chapters 374 and 433 of the Acts of the year 1892, and chapter 283 of the Acts of the year 1893, for the abolition of grade crossings, the treasurer and receiver-general shall establish a sinking fund for the payment of said bonds, into which shall be paid any premiums received on the sale of said bonds; and he shall apportion thereto from year to year, in addition, amounts sufficient with their accumulations to extinguish at maturity the debt incurred by the issue of said bonds. The amount necessary to meet the annual sinking fund requirements, and to pay the interest on said bonds, shall be raised by taxation from year to year.

Section 2. From the proceeds of the sale of the bonds referred to in section 1, there shall be paid into the treasury of the commonwealth such amounts as may have been already expended therefrom under the authority of the Acts mentioned in section 1.

Section 1. An Act Relating to the Abolition of Grade Crossings.—In any proceeding for the abolition of a grade crossing under chapter 428 of the Acts of the year 1890, where the commission is of the opinion that public necessity and convenience require a private way to be changed or discontinued in connection with the abolition of the grade crossing, they may change or discontinue the same; and the damages occasioned thereby shall be primarily recovered against the railroad company, and apportioned and paid under the provisions of said chapter and Acts in amendment thereof.

Section 135. Jurisdiction as to Crossings of Railroads with Public Ways, etc.—Original jurisdiction of all questions touching obstructions to highways or town ways, caused by the construction or operation of

railroads, shall be vested in the county commissioners within their respective jurisdictions.

Section 136. The supreme judicial court may by proceedings in equity compel railroad corporations to raise or lower a highway or town way, when the county commissioners have decided that such raising or lowering is necessary for the security of the public, and to comply with the orders and decrees of county commissioners in all cases touching obstructions to such ways by railroads; and said court or a justice thereof, if it is made to appear in term time or vacation, upon the petition of the mayor and aldermen or selectmen of a place, that a corporation has excavated or altered a highway or town way without obtaining the decree and giving the security required by section 121, or has neglected for 15 days to give security as required by section 127, may, by injunction or other suitable process in equity, restrain it from entering upon, altering, excavating, or crossing the way until such decree is obtained or such security is given. Said court shall have full equity jurisdiction in case of any violation of the provisions of section 94, and also in case the board certifies a location before ascertaining that the authority and consent required by said section have been obtained, and also in case any corporation enters upon or uses any land or other property, except for making surveys, before it has duly filed its location in the county in which such land or other property is situated.

Section 137. An application for damages sustained by the owners of a private way by reason of a railroad crossing the same shall be made within 3 years from the time when the way is so obstructed, and not afterwards.

Section 138. When a railroad lawfully laid out through land without the consent of the owner separates one portion thereof from another, or from a highway or public way, and the owner has a right to cross the railroad, if a difference arises between him and the corporation owning the road as to the place or manner in which he shall cross, or if a crossing is deemed inconvenient, either party may apply to the county commissioners, who, after taking a recognizance from the applicant to the county, with sureties to their satisfaction, for the payment of costs and expenses according to their order, and after due notice to the other party and a hearing, may make such order in relation to such crossing and to the costs of the application as they may deem proper; but they shall not order the corporation to construct or maintain a crossing without its consent, except where it is liable by law or by agreement to construct a crossing for the owner of the land, or is the party making the application.

Section 1. An Act to Require Railroad Companies to Maintain Crossings to Give Access to Lands Cut Off by Railroads.—When any person or corporation is cut off from access to lands owned by such person or corporation by the laying out of a railroad, or the widening of the roadbed of such railroad, and when no compensation has been paid by the company owning or operating said railroad for cutting off access to said lands, or agreement made relative thereto, the railroad commissioners, after due notice to the parties in interest and a hearing, under such rules as they shall adopt for proceedings under this Act, shall, if they deem expedient, order a crossing to be made and maintained at the expense of the railroad company, and shall specify definitely the character of such crossing and when the same may be used.

Section 2. If any railroad company neglects to comply with an order of the railroad commissioners made under this Act for more than 90 days after the date of such order, such company shall forfeit $5 a

day for each day's neglect after the expiration of said 90 days. Said forfeiture may be recovered by any person or corporation aggrieved in an action of tort brought in any police, district or municipal court, or in the Superior Court sitting for the county within which the crossing was ordered to be maintained. One-half of the amount recovered shall be paid to the person or corporation instituting the suit and the other half to the county.

Section 1. An Act Relative to the Abolition of Grade Crossings.—Any order, appointment or decree which can be made by the Superior Court or a justice thereof, under the provisions of chapter 428 of the Acts of the year 1890 and Acts in addition thereto or in amendment thereof, may be made in any county.

Section 1. An Act Relative to the Abolition of Grade Crossings of Railroads and Private Ways.—The provisions of chapter 428 of the Acts of the year 1890, entitled "An Act to promote the abolition of grade crossings," and of the several Acts in amendment thereof and in addition thereto, shall apply to the crossings of private ways and railroads at grade; provided, however, that the entire cost, damage and expense of abolishing such crossings, except in cases where the private way is changed or discontinued in connection with the abolition of the grade crossing of a public way, shall be apportioned to and paid by the railroad corporation.

Section 1. An Act to Provide for Allowing Costs to Parties Recovering Damages in Grade Crossing Cases.—In all proceedings for the recovery of damages sustained in the abolition of grade crossings and the separating of the grades of highways and railroads, parties recovering damages shall also recover costs, as in other civil cases; and the court before which the trial is had may, as a part of such costs, in its discretion, make allowances for reasonable expenses incurred for surveys and plans.

Section 163. Grade Crossings of Railroads with Traveled Ways.—Every railroad corporation shall cause a bell of at least 35 pounds in weight and a steam whistle to be placed on each locomotive engine passing upon its road; and such bell shall be rung, or at least three separate and distinct blasts of such whistle sounded, at the distance of at least 80 rods from the place where the road crosses upon the same level any highway, town way, or traveled place over which a signboard is required to be maintained as provided in the two following sections; and such bell shall be rung, or such whistle sounded, continuously or alternately, until the engine has crossed such way or travelled place.

Section 1. An Act to Authorize the Railroad Commissioners to Forbid or Regulate the Sounding of Locomotive Whistles in Certain Cases.—The board of railroad commissioners may by an order in writing, for good cause shown, on petition and after notice to any railroad company and a public hearing had thereon, forbid or regulate the sounding of whistles on the locomotives of such company at any specified grade crossing or crossings of the tracks of such company with any highway or public way within this commonwealth. The railroad company in relation to which such order is made shall thereafter, until the same shall be modified or annulled by said railroad commissioners, conform in all respects to the terms of such order.

Section 1. An Act Relative to Signals of the Approach of Trains to Crossings Above the Level of a Highway.—The board of railroad commissioners may require a railroad corporation whose railroad crosses a highway by a crossing above the level of the highway to give such signal of the approach of trains to any such crossing as the board may designate. The board may determine the nature of the

signal to be given in each case, and may in its discretion require an automatic signal. The supreme judicial court may by suitable process in equity compel railroad corporations to comply with orders made by the board under this section.

Section 164. Signboards.—Every railroad corporation shall cause boards, well supported by posts or otherwise at such height as to be easily seen by travelers, and not obstructing travel, containing on each side in capital letters at least 9 inches high the following inscription: RAILROAD CROSSING—LOOK OUT FOR THE ENGINE, to be placed and constantly maintained across each highway or town way where it is crossed by the railroad at the same level; or the corporation may substitute for such posts and boards warning boards on each side of the crossing, of such form, size, and description as the board shall approve. The supreme judicial court, by injunction or other suitable process in equity, may compel a compliance with the provisions of this section.

Section 165. The mayor and aldermen of a city or the selectmen of a town wherein a traveled place is crossed by a railroad at the same level, if of opinion that it is necessary for the better security of the public that boards, such as are described in the preceding section, should be maintained at such traveled place, may in writing request the railroad corporation to erect and maintain them. If it refuses or neglects so to do, they may apply to the county commissioners. If the commissioners, after due notice and hearing of the parties, decide that such erection is necessary for the better security of the public, the corporation shall comply with their decision, and shall pay the costs of the application. If they decide that it is not so necessary, one-half of such costs shall be paid by the city or town, and one-half by the corporation.

Section 166. Gates or Bars—Flagmen.—The mayor and aldermen of a city or the selectmen of a town wherein a highway, town way, or traveled place is crossed by a railroad at the same level, if of opinion that it is necessary for the better security of the public that gates should be erected across such highway, town way, or traveled place, and that an agent be stationed to open and close such gates when an engine or train passes, or that bars be erected instead of gates, or that a flagman be stationed at the crossing, who shall display a flag whenever an engine or a train passes, may in writing request the corporation to erect and maintain gates and station an agent thereat, or to erect bars, or to station a flagman at the crossing; and, if it refuses or neglects so to do, may apply to the county commissioners. Upon such application, or at any time upon the petition of any party, after due notice and hearing, the county commissioners may make such orders for the erection and maintenance of gates or bars, or the stationing of an agent or flagman, or such alteration of arrangements already existing at a crossing, as they shall decide that the better security of human life or the convenience of the public travel requires, and may make such order as to costs as justice may require; and the corporation shall comply with all such orders, whether made before the railroad is constructed and opened for use, or from time to time afterwards.

Section 167. An agent stationed at a crossing under the provisions of the preceding section who neglects to open or close the gates for the safe passing of an engine on the railroad or of a traveler on the highway or other way, or a flagman so stationed who neglects to display his flag, shall for every such neglect forfeit a sum not exceeding $100; and the corporation shall also be liable for all damages sustained by any person by reason of such neglect of its agents.

Section 168. A railroad corporation which unreasonably neglects to comply with an order or decision made under sections 165 or 166, shall forfeit for every such neglect a sum not exceeding $1,000. The supreme judicial court may by suitaable process in equity compel railroad corporations to comply with such orders and decisions.

Section 1. An Act to Amend an Act to Promote Safety at Railroad Grade Crossings.—At any point where a highway, town way or traveled place is crossed at the same level by a railroad, the board of railroad commissioners may, after notice to and hearing of the railroad corporation whose road so crosses, direct in writing that gates shall be erected across said way or place and that an agent be stationed to open and close such gates when an engine or train passes, or that a flagman be stationed at the crossing who shall display a flag whenever an engine or train passes, or that such crossing shall be furnished with such electric signal or signals as they shall decide the better security of human life or the convenience of the public travel require; and the corporation shall comply with such order.

Section 1. An Act to Promote the Safety of the Public at Grade Crossings.—A railroad corporation, or any ten citizens of a town, for the purpose of promoting the safety of public travel, may, where the view of a railroad crossing or highway at grade is obstructed by standing wood in woodlands, petition the county commissioners for the county where such obstruction exists in woodlands, who shall, after such notice as they deem proper, hear the parties and make such order in the premises in regard to the removal of said standing wood as the public safety shall demand.

Section 2. Said commissioners shall prescribe the limits within which standing wood shall be taken, and shall determine the damage sustained; and such damage and the expenses arising therefrom shall be paid by said railroad corporation. Said damages and expenses shall be assessed and collected in the manner provided in the case of the taking of land by railroad corporations; and either party, if dissatisfied with the decision of the commissioners, may have the same right of appeal therefrom as is provided in the case of the taking of land by railroad corporations.

Section 3. Nothing herein contained shall be construed as authorizing a railroad corporation to acquire lands except as it is now authorized so to do.

Section 4. This Act shall take effect on the 1st day of June in the year 1889.

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§ 5222. Section 17. Whenever, in the opinion of the commissioner of railroads, the safety of the public would be more efficiently secured by stationing a flagman to signal trains where a highway or street is crossed by any railroad, or when one railroad [crosses] crossing or intersects another railroad, or by the building of a gate or bridge at such highway, street or railroad crossing or intersection, or street railway crossing, he shall direct the corporation or corporations owning or operating any such railroad or railroads to station a flagman, or to erect and maintain a bridge or gate at such crossing as the public safety may demand; and in case such flagman is directed to be stationed, or gate or bridge directed to be erected and maintained where one railroad crosses or intersects another, the expense thereof shall be born jointly in equal proportions by the companies owning or controlling each of said railroads. Any corporation or corporations neglecting or refusing to construct and maintain such gate or bridge, or to maintain such flagman so

directed as aforesaid, shall each forfeit for every such neglect or refusal the sum of $100, and the further sum of $10 for every day which such neglect or refusal shall continue; and if said flagman shall neglect to display his flag, or perform such other duties as may be required of him by said commissioner, he shall, for every such neglect, be liable to a fine of $25, and shall also be liable for all damages sustained by any person by reason of such neglect, to be recovered in an action of tort; provided, the corporation owning or operating any such railroad shall not be released from liability therefor, but shall be subject to the same liability at the option of the aggrieved party.

§ 6281. Section 2. On and after July 31, 1873, every company, person or corporation owning or operating a railroad within this state shall construct and maintain a gate or gates, or bridge, or maintain a flagman to signal trains at every highway or street crossing on the line of such road, where the same shall be required by the commissioner of railroads as hereinafter provided. Any company, person or corporation neglecting or refusing to construct or maintain such gate or gates, or bridge, or to maintain such flagman where so required as aforesaid, shall forfeit for every such neglect or refusal the sum of $100, and the further sum of $10 for every day while such neglect or refusal shall continue.

§ 6282. Section 3. Whenever, in the opinion of the commissioner of railroads, the public interests require that a gate be constructed and maintained at any railroad crossing, or a bridge be built over such railway at such crossing, or that a flagman be stationed and maintained at such crossing, he shall give to the superintendent of such railroads a written notice that the same is required; and such company, person or corporation shall construct or maintain the same within such time thereafter as said commissioner shall prescribe.

§ 6283. Section 4. All gates constructed under this act by requirement of the commissioner of railroads shall be built in such manner, and within such time, and of such material as shall be approved by the commissioner of railroads, and shall be located on the highway or street on one or both sides of the railroad track or tracks, as the commissioner may deem the public safety to require, and shall be so constructed as, when closed, to obstruct and prevent any passage across such railroad or railroads from the side on which such gate may be located. At every gate heretofore or hereafter constructed at any crossing of a street or highway and a railroad there shall be a person in charge at such hours of the day or night as the said commissioner of railroads shall from time to time order and direct, and it shall be his duty to close the same at the approach of a train of cars or of a locomotive, and to keep it open at all other times; and it shall be the duty of the gatekeeper on either side of one or more tracks to close the gate of which he is in charge on the approach of a train of cars or locomotive, on either track. For every neglect of such duty such person, upon conviction thereof, shall pay the sum of $25, or be imprisoned in the county jail for the period of 90 days, or both, in the discretion of the court. The expense incurred in the erection and maintenance of the gates provided for in this section, and of the necessary gatekeepers, shall be shared equally by the railroad companies alongside whose tracks the gates shall be located. Any person who shall open or raise such gate when closed or lowered, or attempt so to do, or shall attempt to gain access with teams or vehicles to such crossing while the gate is closed or lowered, shall be guilty of a misdemeanor, and on conviction thereof shall be punished by a fine of not less than $10 or more than $25, with the alternative of imprisonment in the county jail for a period of not more than 30 days.

§ 6292. Section 13. A bell of at least 30 pounds' weight, and a steam whistle, shall be placed on each locomotive engine, and said whistle shall be twice sharply sounded at least forty rods before the crossing is reached, and after the sounding of the whistle the bell shall be rung continuously until the crossing is passed, under a penalty of $100 for every neglect; provided, that at street crossings, within the limits of incorporated cities or villages, the sounding of the whistle may be omitted, unless required by the common council or board of trustees of such city or village; and the company shall also be liable for all damages which shall be sustained by any person by reason of such neglect. Every railroad corporation shall, and they are hereby required to, cause signal boards to be placed, well supported by posts or otherwise, and maintained at each public road or street where the same is crossed by the railroad track at grade. The board shall be so elevated as to not obstruct the travel, and to be seen by people before reaching the crossing, and on each side of such board shall be painted in letters not less than 12 inches in height, the words, "Railroad Crossing;" but such boards need not be put up in cities or villages, unless required by the proper officers thereof, or upon the order of the commissioner of railroads. This provision shall not apply to signal boards already erected.

§ 6294. Section 15. Every railroad company formed under this act, or any former act, and every corporation owning or operating any such railroad, shall erect and maintain in effective condition of repair fences on each side of the right-of-way to their respective roads, as hereinafter provided. A legal railroad fence shall not be less than four and one-half feet high, and shall be made of boards and posts in combination, as follows: The boards to be of pine or hemlock, six inches in width and 16 feet in length; the posts to be of cedar, tamarack or oak, not less than seven feet in length and five inches in diameter, to be set not less than two and one-half feet in the ground, at a distance apart not more than eight feet from center to center. First a board shall be nailed to the posts close to the ground; five inches above such first board, a second; six inches above the second, a third; six inches above the third, a fourth; six inches above the fourth, a fifth, all to be capped with a like board, securely nailed to the fifth board and to the posts. All the boards to be firmly nailed to the posts with not less than two eight or ten penny fence nails at each post. Or it may be constructed of posts, boards and wire in combination, as follows: The posts shall be of cedar, tamarack or oak, not less than seven feet in length and five inches in diameter, to be set not less than two and one-half feet in the ground, at a distance apart of not more than eight feet from center to center. At a height of 16 inches from the ground a pine or hemlock fence board, six inches in width, and seven inches above such first pine or hemlock board, a second of the same width, both fence boards to be firmly nailed to the posts with two eight or ten penny fence nails at each post. At the height of five inches from the ground a barbed fence wire, and at ten inches from the ground a second barbed wire; 44 inches from the ground, or nine inches from the second pine or hemlock board, a third barbed wire, and 53 inches from the ground, or nine inches above the third barbed wire, a flat Brinkerhoff strip, or some other metallic strand of similar pattern; or it may be constructed with such posts, and set as above described, and made as follows: At a height of four inches from the ground, a barbed fence wire; at nine inches from the ground, a second barbed fence wire; at 14 inches from the ground, a third barbed wire; at 20 inches from the ground, a fourth barbed wire; at 28 inches from the ground, a fifth barbed wire; at 37 inches from the ground, a sixth barbed wire; at 48 inches from the ground, a six-inch pine or hemlock fence board, capped with a six-inch pine or

hemlock fence board. Such wires and strips to be properly strained, and the posts sufficiently braced wherever necessary to prevent the wires from becoming loose or sagging, and the wires to be securely fastened to the posts with sufficient staples. All inequalities of the ground under the fence to be surfaced and leveled so that no animals can pass under the lower strand; provided, that any fence or cattle-guard which shall have the written approval and indorsement of the commissioner of railroads of this state, and which fence is not less than four and one-half feet in height and is otherwise equal in durability, strength and sufficiency to turn animals and stock to the fences herein described, shall be a legal railroad fence or cattle-guard; provided, further, any railroad company that has already erected fences along the line of its right-of-way may allow the same to remain until otherwise ordered by the commissioner of railroads; but in such case said railroad company or corporation shall be liable for all damages done to animals or stock coming upon its right-of-way through or over such fence, but on the trial of any action for damages, if it shall be shown that the fence through or over which such animals or stock entered upon such right-of-way was four feet in height and otherwise equal in strength and sufficiency to turn animals or stock to the fence provided for in this Act, then no damages shall be recovered. Such right-of-way fences shall be provided with suitable connecting fences and cattle-guards at all highway and street crossings, which shall at all times be kept in effective repair and sufficient to prevent stock of all kinds from passing upon the track of the railroad at such highway or street crossings. Convenient farm crossings shall also be constructed by any such railroad corporation across the right-of-way and track of its railroad, with the necessary gates or bars therefor, as the owner or occupant of the premises may elect, at the sides of the right-of-way, which such gates or bars shall be of sufficient width to admit the free and easy transportation of all farm machinery, including harvesters or binders, in form as the same are usually drawn, upon the application of the owner or owners of land lying upon both sides of such railroad track, the same being inclosed by exterior fences, and being adjacent to such right-of-way. And in cases where a railroad is immediately adjacent to or laid upon a highways and intervenes between said highway, or the usually traveled portion thereof, and the residence buildings of real property fronting upon said highway, open, unobstructed residence crossings, suitably guarded, substantially as are provided for highway and street crossings, shall be provided and maintained by the railroad corporation operating said railroad; provided. the same shall be so ordered by the railroad commissioner. And in case of disagreement between the owner of any such land and the railroad corporations as to the necessity for, location of, or character of farm crossing, or such residence crossings so applied for, or as to the plan or construction of the gate or guards as herein provided, then either party may present the matter in dispute to the commissioner of railroads, who may proceed to investigate the same as soon as may be and render his decision thereon, which shall be final and binding upon the parties respectively, and such farm crossings and such residence crossings shall be constructed within the time prescribed by the said commissioner of railroads under a penalty of $10 for each and every day that such complete construction of the farm crossing or residence crossing shall be delayed beyond the expiration of the time fixed for its completion by the said commissioner of railroads. And such railroad corporation shall also be liable to the owner or occupant of said adjacent lands for all actual damages resulting from its failure to construct and maintain and properly guard such open and obstructed way as herein

provided for such residence crossings. And until such crossings, fences and cattle-guards as hereinbefore provided for shall be duly constructed the company or corporation owning or operating such road shall be liable for all damages done to cattle or other animals thereon which may result from the neglect of such company or corporation maintaining or operating such road to construct and maintain in repair such crossings, fences and cattle-guards as aforesaid, to be recovered by the owner of such cattle or other animals in a civil action before any court of competent jurisdiction, and after such company or corporation shall have constructed such crossings, fences and cattle-guards as hereinbefore provided, and while they shall continue to maintain the same in good and sufficient repair, it shall not be liable for any such damages as aforesaid, unless negligently or willfully done. And every such company or corporation owning or operating any such railroad shall, within three months from the time any section or portion of such road is finished and put in general use by running regular trains thereon, and in the case of any roads now in use from the time this act shall take effect, erect and maintain the crossings, fences and cattle-guards as herein provided. Any violation of the provisions of this section on the part of any railroad corporation owning or operating any railroad in this state, by failure or neglect to construct and maintain crossings, fences and cattle-guards as herein required, shall be punished by a penalty of $25 per day for each and every day that such neglect or failure shall continue; provided, that if such fences and cattle-guards shall not be built as aforesaid along such portions of any line of road as is or may be constructed north of a line extending due west from the mouth of the Saginaw river, the corporation or company owning or operating any such line of road shall not be liable to the said penalty unless such fence or cattle-guards shall be ordered by the commissioner of railroads, but shall be liable to all the other provisions of this section; and if any person shall ride, lead, or drive, or intentionally permit any horse or other animal upon such road and within such fences or cattle-guards other than farm crossings or residence crossings, or shall injure or destroy, or make openings or passages through or over such fences or cattle-guards, or neglect to close any gates or bars immediately after passing through the same, without the consent of such company or corporation, he shall, for every such offense, be liable to a fine not exceeding $100, and shall also pay all damages which shall be sustained thereby to the party aggrieved; provided, further, that nothing herein contained shall be construed to prevent the erection of any other fence than that herein provided for, as may be agreed upon in writing between the duly authorized agent or officer of any railroad corporation and the owner of any land through which the road of such corporation [shall] may be in operation.

§ 6301. Section 22. (23.) Every railroad corporation constructing its road upon or across any stream of water, watercourse, private road, street, lane, alley, or highway, across any plank road, railroad or canal, which the line of its road shall lie along or intersect, and shall fail, neglect, or refuse to restore such stream, watercourse, private road, street, lane, alley, highway, plank road, railroad or canal to its former condition as nearly as possible, as is provided by the fifth subdivision of section 9 of article 2 of this Act, shall be liable to a penalty of not less than $5 nor more than $25 for each and every day that they shall fail, neglect, or refuse to perform the things hereinbefore specified and required to be performed; provided, that all culverts or other openings in or under the roadbed of any such railroad corporation, made for the flow of water, shall be so constructed as not to interfere with the proper and thorough drainage of the land above such railroad. And any railroad corpora-

tion or company owning or operating a railroad in this state that shall permit its engines, cars or trains to obstruct any public street or highway for a longer period than five minutes at any one time shall be liable to a penalty for each offense of $25. The penalties provided for each case herein shall be recovered in an action to be brought in the name of the people of Michigan by the prosecuting attorney of the proper county, in which the offense charged shall have been committed, upon the complaint of the proper authorities of any city, village or township, or of any citizen injured or aggrieved by the violation by any railroad corporation or company of the provisions of this act in this section contained.

An Act to revise and consolidate the laws relative to the establishment, opening, improvement and maintenance of highways and private roads, and the building, repairing and preservation of bridges within this state.

§ 4068. Section 27. In laying out any highway under the provisions of this Act, where the same crosses the track or right-of-way of any railroad company, the same proceedings in relation to acquiring the right-of-way for such highway across the land of such railroad company, including the right-of-way across the tracks, shall be had as in other cases. Service of all papers shall be made in the same manner upon such railroad company as is provided by law for the service of summons on railroad companies. Such railroad company shall be entitled to receive the actual value of the use of the land taken for such highway, and when the compensation awarded such railroad company for such damages as above provided shall have been paid or tendered to any person in charge of the ticket or freight offices of such company entitled thereto and situated nearest the said highway crossing, pursuant to the provisions of section 24 of this chapter, then and in such case such right-of-way shall be deemed to be fully acquired and secured for the public. After the right-of-way has been acquired the commissioner of railroads of this state shall, on application of the highway commissioner, furnish plans and specifications of approaches, cattle-guards, fences and other safeguards as may be necessary to make such crossing reasonably safe for the use of the public and all business of such railroad, and thereupon, upon receipt of such plans and specifications, the highway commissioner shall advertise for proposals for opening such highway across the right-of-way and tracks of such railroad company, according to such plans and specifications, as provided in other cases for letting all contracts by highway commissioners, for constructing and improving highways and bridges. Such railroad company is hereby required to furnish a competent superintendent or trackman to superintend the construction of such crossing, and such township shall pay to such railroad company a per diem compensation for such superintendent, not exceeding $2 per day for the time actually and necessarily spent in superintending such construction, and such highway commissioner is authorized to issue orders in payment of such contract and for the payment of such superintendent, as provided by law. In case such railroad company refuses or neglects to furnish a superintendent for the construction of such crossing as aforesaid, then and in such case it shall be the duty of the commissioner of railroads to appoint some suitable person, who shall receive the compensation aforesaid from the said township, to oversee and superintend the construction of such crossing; provided, that in cases where the expense of constructing such crossing shall be less than $50, the same may be performed by the said highway commissioner, under the supervision of a superintendent, as aforesaid, without the letting of any contract, and

such commissioner of highways is authorized to draw orders for the payment of the same as in other cases. If any railroad company shall attempt to obstruct the opening of any such highway after such right-of-way has been secured and payment of damages herein provided for has been made and tendered as herein provided, by any agent, officer or employe or any other person, the said railroad company shall be liable to a penalty of $25 for each day the opening or construction of such highway is delayed or impeded, for the benefit of the township; and the highway commissioner may sue for and recover such penalty in any of the courts of this state; and in addition thereto, if any officer, agent or employe, or person acting for and in the interest of any railroad company, shall annoy, hinder or obstruct any highway commissioner, contractor or person employed by him or them in opening such highway or constructing any grades, approaches, cattle-guards, crossings or fences required to complete, or for the use of such highway and the public, such officer, agent, employe or person shall be deemed guilty of a misdemeanor, and on conviction thereof shall be fined not to exceed $100, or imprisoned in the county jail not to exceed 90 days, or both such fine and imprisonment, in the discretion of the court.

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§ 4229. An Act to provide separate grades for railroads and public highways and streets where railroads intersect such highways and streets. Section 1. The people of the state of Michigan enact: That where any railroad crosses, or shall hereafter cross, any public street or highway, the separation of the grades at such crossing by carrying such street or highway either over or under such railroad or railroads at the point of intersection may be effected as follows:

An agreement therefor as herein provided may be made with such railroad or railroads:

(a) Where said crossing is within the limits of any city, by the common council of said city.

(b) Where said crossing is within any county outside the limits of any city and upon any state or territorial road, by the board of supervisors of said county.

(c) Where said crossing is within any county outside the limits of any city and upon any county road, by the board of commissioners of county roads, provided for in section 49 of article 4 of the constitution.

(d) Where said crossing is within any township outside the limits of any city and upon any township road, by the township commissioner of highways.

(e) Where said crossing is on the line between any city and the territory outside such city, as follows:

1. Where the crossing is on a state or territorial road, by the joint action of the common council of the city and the board of county supervisors.

2. Where the crossing is on a county road, by the joint action of the common council of the city and the board of commissioners of county roads.

3. Where the crossing is on a township road, by the joint action of the common council of the city and the township commissioner of highways.

(f) Where the crossing is on the line between two or more counties, or between two or more townships of the same county, by the joint action of the boards of county supervisors, boards of commissioners of county roads, or township commissioners of highways, according as the crossing is on a state or territorial road, a county road or a township

road. Or judicial proceedings may be instituted to obtain such separation of grades in accordance with the provisions of section 10 of this Act. The words "representative board or officer," where occurring hereinafter, shall be understood to mean board or boards of supervisors, board or boards of commissioners of county roads, township commissioners or commissioners of highways, common council, or any two or more of them, as the case may be.

§ 4230. Section 2. Such representative board or officer, as the case may be, may enter into an agreement with any railroad company or companies crossing any such street or highway providing for the separation of the grades at such crossing by carrying said street or highway either over or under said railroad at the point of intersection. Said agreement shall have attached thereto as a part thereof an accurate profile and map of those portions of the street or highway and railroad or railroads of which the grade is to be changed according to the said agreement, and a plan showing the details of construction necessary for the separation of the grades at such crossing. Said agreement shall also provide for paying the cost of making and maintaining such separation of the grades and for the division of the total expense thereof between the parties to such agreement, and shall fix the amount of damages, if any, to be paid to said railroad company or companies as compensation for any injury to it or them resulting from said changes of grade, exclusive of the expense of construction and maintenance above provided for; provided, that no such agreement shall be enforceable until the damages referred to in section 3 of this Act are fixed by judicial proceedings or by compromise under said section 3; provided, further, that no agreement made by a board of county supervisors, board of county commissioners or highways, or township highway commissioner, which necessitates the borrowing or raising by tax of a greater sum by the county or township than such board or [commissioner] commissioners is authorized to raise, shall be enforceable until the authority to raise such excess has been duly given; nor shall any agreement made by a township commissioner of highways be valid until the same is approved by the township board.

§ 4231. Section 3. When the common council of any city shall have entered into any such agreement, it shall be authorized to settle or compromise with any person having an interest in any lands abutting on that portion of the street or highway within the city of which the grade is to be changed according to the said agreement, and which may be damaged by the proposed change of grade, and with any street railroad company operating or interested in any line of street railway upon such part of such street or highway, and which may be damaged thereby. When a common council, being a party to such agreement, cannot effect such settlement or compromise, or shall deem it inexpedient to attempt it, or whenever the representative board or officer of any county or township is a party to such agreement, such common council or representative board may pass a resolution, or such representative officer may make a certificate, declaring it necessary for the public benefit to make such separation of grades in accordance with the plan prescribed by said agreement, which resolution or certificate shall have attached thereto, as a part thereof, a copy of the said agreement. Upon the passage of such resolution, or the making of such certificate, it shall be filed in the office of the city attorney of the city where the crossing is within the city, or upon the line between any city or county, or part of a county outside of such city, and in the office of the prosecuting attorney of the county where the crossing is outside of the limits of any city and within such county. Where the crossing is on the line between two or more counties, the resolution so passed shall be transmitted to the railroad

and street crossing board hereinafter provided for, who shall file the same in the office of the prosecuting attorney of either of the counties interested, as the said crossing board shall determine. And said resolution shall also be recorded in the office of the register of deeds of the county or counties in which such crossing is situate within 20 days after its adoption. The question of the necessity of making the proposed change or changes of grade shall then be passed upon, and the damages, if any, shall be appraised in judicial proceedings in the manner hereinafter provided. But in any proceedings instituted on any such resolution said agreement shall be conclusive evidence of the amount of compensation to be awarded to said railroad company or companies, and no benefits shall be assessed against any railroad company that is a party to such agreement.

§ 4232. Section 4. The governor, within 10 days after this Act shall take effect, shall appoint, by and with the advice and consent of the Senate, two persons, who, together with the commissioner of railroads, shall constitute a railroad and street crossing board. Said board shall have and keep their office at the office of the said commissioner of railroads. One of said persons so appointed and to be named shall hold office until the first day of January in the year of our Lord 1895 and until his successor is appointed and qualified, and the other until January 1, 1897, and until his successor is appointed and qualified. At the regular session of the legislature next thereafter, and every two years thereafter, the governor, by and with the advice and consent of the Senate, shall appoint one member of said board, who shall hold office for the term of four years from the first of January in the year of his appointment and until his successor is appointed and qualified.

§ 4233. Section 5. No person shall be appointed as a member of said board who is not a citizen of this state, and who, at the time of his appointment, is in any way connected with any railroad corporation, and who is directly or indirectly interested in any stock, bond or other property of, or is in the employ of any railroad corporation, and no person so appointed shall, during the term of his office, become interested in any stock, bond or other property of any railroad company, or in any manner be employed by or connected with any railroad corporation.

§ 4234. Section 6. The governor shall have power to remove for cause any such member, and appoint another to fill the vacancy at any time, in his discretion, but the reasons for such removal shall be laid before the Senate at the next regular or special session of the legislature thereafter, and in case of a vacancy in the office of any such member the governor may appoint another person to fill the same.

§4235. Section 7. Before entering upon the duties of his office the person so appointed shall make, subscribe and file in the office of the secretary of state, an oath of office in the form prescribed by section 1, article 18, of the constitution of this state, and shall enter into bonds with the people of the state of Michigan in the sum of $10,000, with sureties to be approved by the governor, conditioned upon the faithful performance of his duties.

§ 4236. Section 8. Each of said members, other than the commissioner of railroads, shall receive as compensation the sum of $10 for each and every day spent in the performance of his duties. He shall be reimbursed for all actual cash outlay for railroad and hotel fares, and other expenses incurred in the performance of his duties. His bills for services and expenses shall be audited by the board of state auditors and paid from the state treasury.

§ 4237. Section 9. If any railroad company operating a railroad which crosses any such street or highway and the representative board

or officer are unable to agree, in accordance with the provisions of section 2 of this Act, or if such agreement having been made fails to become enforceable by reason either of a failure to agree with the abutting property-owners, or with any street railway company, under the provisions of section 3 of this Act, or of a finding of the commissioners hereinafter provided for against the necessity of the proposed separation of grades, then, on presentation to the board of railroad and street crossings of a certificate made by such representative officer, or of a certified copy of a resolution passed by said representative board or boards, or when more than one board is interested, by any one of them declaring that the separation of the grades at said crossing is necessary for the public benefit, or on presentation to said crossing board of a petition signed by 20 owners of real estate abutting on said street or highway, praying said board to investigate the necessity of separating the grades at such crossing, it shall thereupon be the duty of the said board to investigate the necessity of the separation of the grades at such crossing. Before proceeding with such investigation said board shall cause a notice of the time and place at which the investigation will commence to be served at least 10 days before the time set for the investigation upon the prosecuting attorney of each county interested, if any, and upon the highway commissioner of each township interested, if any, upon the city attorney of the city interested, if any, either personally or by leaving such notice at the office of such prosecuting attorney or city attorney or commissioner, with some person in charge thereof, or if such office is not open so as to admit of service, by leaving such notice at the residence of such attorney or commissioner, with some person of suitable age and discretion. Within the same time said board shall cause such notices to be served upon each railroad company interested in said crossing by leaving a copy thereof at the principal business office of such company situate within this state with either the president, vice-president, general superintendent, or general manager of such company, or if none of said officers can be found, then by leaving said copy with any officer or agent of said company in charge of any of its stations or depots within this state. Any corporation or body politic so notified and any other person interested in said crossing may attend upon said investigation. If the board or a majority thereof determine that a separation of grades is necessary they shall determine whether the grade of said railroad or railroads shall be raised or lowered, and how much, and whether the grade of said street or highway shall be raised or lowered, and how much; provided, that in such separation of the grades the maximum of one foot in 10 for the new grade of the street or highway, and one foot in 100 for the new grade of the railroad shall not be exceeded. And having determined the manner of making such separation as they, or a majority of them, shall deem best, they shall also estimate as near as may be and determine the cost and expense of doing and constructing the work provided by section 27, to be done by said railroad company or companies, and the portion of such cost or expense if any, which it would be just and equitable that the city, county or township, by whom it is provided herein, the expense of such separation shall be paid, shall pay to said company or companies, as its fair share thereof, and they shall also determine the cost and expense of the work to be done or constructed by the city, county or township, as provided by said section 27, and the portion thereof, if any, which would be just and equitable, that said company or companies should pay to said city, county or township, as its or their fair share of the said cost and expense. They shall adopt a plan showing the details of construction necessary for the separation of the grades at such crossings by carrying such street or highway either over or under said

railroad or railroads, as they or a majority of them shall deem best. They shall have an accurate profile and map made of those portions of the street or highway and railroad or railroads of which the grade is to be changed. They shall make report signed by a majority of the said board, setting forth in detail the plan by them adopted as aforesaid, to which report shall be attached as a part thereof the plan of construction, and profile, and map above referred to, and in which report shall be stated the cost and expense as determined by them of doing and constructing the work to be done by said railroad company or companies, and the portion thereof, if any, which it would be just and equitable that the city, county or township shall pay to said company or companies, as above provided, and also the cost and expense of the work to be done or constructed by the city, county or township, and the portion thereof, if any, which would be just and equitable that said company or companies should pay to said city, county or township, as above provided, which report shall be filed in the office of the city attorney of the city when the crossing is within a city or on a line between the city and the county, and in the office of the prosecuting attorney of any county where the crossing is outside of any city and within such county, or on the line between such county and any other county or counties. To assist said board in determining upon and making said plan, profile, map, estimates, and the report herein mentioned, they may employ an engineer, and such clerical assistance as they may need. The expense of such employment shall be audited and paid in the same manner as provided for their other expenses.

§ 4238. Section 10. Upon the filing either of the resolution or certificate referred to in section 3, or of the report referred to in section 9, it shall be the duty of the officer with whom said resolution, certificate or report is filed, to institute proceedings without delay in behalf of the city or county, or of the township whose commissioner made the certificate, as the case may be, in the proper court, to carry out the object of said resolution, certificate or report. When said resolution, certificate or report is filed with the prosecuting attorney of a county, said proceedings shall be had in the Circuit Court for that county. When said resolution, certificate or report is filed with the city attorney of a city, said proceedings shall be had in the Recorder's Court of the city, if there be one, but if not, then in the Superior Court of the city, if there be one, and if there be neither Recorder's Court nor Superior Court, then in the Circuit Court of the county in which the city is situated; provided, that if the crossing be on the line between the city and territory outside the city limits, the proceedings shall be had in the Circuit Court of the county in which the city is situated.

§ 4239. Section 11. Said prosecuting attorney or city attorney, as the case may be, shall forthwith prepare and file in the name of the county, township, or city in the court having jurisdiction of the proceedings, a petition signed by him in his official character, and duly verified by him, to which petition a certified copy of the resolution, or certificate of the representative board or officer referred to in section 3, or of the report of said railroad and street crossing board, as the case may be, shall be annexed, which certified copy shall be prima facie evidence of the action taken by said board or officer and of the proceedings prior thereto and of the regularity thereof. The petition shall state that it is made and filed as commencement of judicial proceedings by the county, township or city, as the case may be, in pursuance of this act, for the purpose of separating the grades of the street or highway and railroad or railroads at their intersection, designated by any proper descriptive words, in accordance with the plan set forth in said resolution, certificate

or report, as the case may be, referring thereto, and for making just compensation to all persons sustaining damage thereby, shall give a description of the property abutting on that part of said street or highway of which the grade is to be changed, also a statement of the manner in which said property and any street railroad line on said street or highway will be affected by said change, and to what extent, and shall state that said representative board or officer or said railroad and street crossing board, as the case may be, has declared it necessary for the public benefit to make said separation of grades in accordance with the plan set forth in said resolution or certificate or in said report, as the case may be, shall contain the names of the railroad companies and street railroad companies to be affected by the proposed change, and of all persons interested as mortgagees, lessees, or otherwise, in the property of such companies, of the owners and others interested in the property abutting on that portion of said street or highway of which the grade is to be changed, so far as the same can be ascertained, including those in possession of the premises, and in cases where the crossing is of a class embraced in clause (e) or (f) of section 1 of this Act, the name of the city, or of the county or counties, township or townships interested, other than the county or township in whose name the proceedings are taken, as the case may be. If the name of any person interested in any of the abutting property is unknown, the petition shall state the fact and the interest owned by such person or persons. All persons, corporations and bodies politic and corporate, so named in said petition, shall be made parties respondent in said petition. Said petition shall ask that a jury be summoned and empaneled to ascertain and determine whether it is necessary for the public benefit to make such separation of grades in accordance with said proposed plan, and to ascertain and determine the just compensation to be made to street railroad companies, if any, and to the persons interested in said abutting property. And to assess the compensation, cost and expense by them awarded against the city and county or counties, township or townships, company or companies, as the case may be, that are parties to the proceedings, as provided by law. Upon receiving such petition it shall be the duty of the clerk of said court to issue a summons against the respondents named in said petition, stating briefly the object of said petition and commanding them in the name of the people of the state of Michigan to appear before said court at a time and place to be named in said summons, not less than 20, nor more than 40, days from the date of the same, and show cause, if any they have, why the prayer of said petition should not be granted.

§ 4240. Section 12. Said summons shall be served by the sheriff, under sheriff, or a deputy sheriff of the county, or in proceedings pending in the Recorder's Court or Superior Court of any city by any member of the police force of such city, at least five days before the return day thereof, upon all the respondents found within the county, by exhibiting the original and delivering a copy thereof to each of them. If any respondent who is a resident of the county cannot be found, the summons shall be served by leaving a copy thereof at his usual or last place of abode with some person of suitable age and discretion. If any minor or person of unsound mind is a respondent, service may be made on the guardian of such person, if there be one, and if there is no guardian the court may appoint some discreet and proper person to be guardian of such person in such proceedings; and such guardian shall have the authority to represent such person in such proceedings, and the proceedings to appoint such guardian shall be the same as provided in chapter 204 of the compiled laws of 1871 of the state of Michigan. If it shall appear on the return day of the summons that any respondent cannot be

found within the county, and has not been personally served, or is a non-resident, and such respondent has not voluntarily appeared, or if the name of any person interested is unknown, the court may make an order for the appearance of all respondents who have not been personally served and have not appeared, at a date not less than 30 days from the date of such order, and that service be made upon them by publishing a copy of such order, at least once in each week for three successive weeks, before the date set for said appearance, in a newspaper printed, published and circulated within the city or county, as the case may be, and if there be no such paper, then in such paper as the court shall consider to be most generally circulated within the city or county. Alias and pluries summons may be issued and the court may adjourn the proceedings from time to time, as there shall be occasion and as in other civil cases. The return of the officer upon the summons and an affidavit of due publication of the order for appearance, if any, shall be filed in the office of the clerk of the court before a jury shall be empaneled, and such a return of personal service or such affidavit shall be sufficient evidence of service on the respondents and of the manner of service, and such service shall bind the respondents and unknown parties in interest and the property in which they are interested.

§ 4241. Section 13. On the return day of the summons, or on some subsequent day to which the proceedings are adjourned, if no sufficient cause to the contrary has been shown, the court shall make an order that a jury shall be empaneled in the cause to ascertain and determine the necessity for the public benefit of separating the grades of said streets or highways, and of said railroad or railroads at their intersection, in accordance with said proposed plan, and to ascertain and determine the just compensation to be made therefor to the street railroad companies, if any, and persons interested in the abutting property made parties respondent to said petition, and to assess the costs and expenses by the act to be assessed as provided herein.

§ 4242. Section 14. Such jury shall be composed of 12 freeholders of the city or county, as the case may be, and shall be selected and empaneled as follows: The sheriff shall select at least 24 persons, freeholders of said city or county, from whom a jury shall be empaneled in the cause, and the names of said 24 or more persons having been selected and returned by the sheriff, as directed by said order, the court shall thereupon cause such persons to be summoned by the usual process of venire to attend the court on a day to be named in said venire to serve as jurors, and the court shall then adjourn all further proceedings on said petition till the return day of said venire. Said venire shall be served by the sheriff or his deputy, as in other like cases. On the return day of said venire, or on the day to which the proceedings may be adjourned, the court shall proceed to empanel a jury of 12 disinterested freeholders from persons so drawn and summoned. And if such jury cannot be found from the persons who shall attend upon such summons, or if so many of the persons summoned shall be excused or shall be rejected by the court upon challenge or otherwise that there shall not be a sufficient number left to constitute a jury, the court shall order the sheriff of said county forthwith to summon immediately other freeholders of the said city or county to attend as jurors, until a panel of 12 qualified jurors shall be obtained. In empaneling a jury the practice and proceedings shall be the same as in ordinary civil suits, so far as practicable. Four peremptory challenges shall be allowed to the petitioner, and the respondents, who are the persons interested in the abutting property, and any street railroad company, shall collectively be entitled to the same number. If any juror, after being sworn, shall die or become

unable to discharge his duties, the court may appoint another qualified person to serve in his place, who shall be sworn and take his place upon the jury, or may, in its discretion, empanel a new jury.

§ 4243. Section 15. The jury so empaneled shall be sworn or shall affirm that they will justly and impartially ascertain the necessity of separating the grades of said street or highway and of said railroad or railroads, as proposed in said petition, and if they deem that such necessity exists that they will impartially ascertain and determine the compensation to be made to the parties respondent and unknown parties in interest named in said petition. The jury shall hear the proofs and allegations of the parties and the arguments of counsel and if so ordered by the court to go to the place of intended improvement, and in charge of an officer, and upon, or as near as practicable, to any property claimed to be damaged in making the same and examine the premises. They shall be instructed as to their duties and the law in the case by the court, and shall retire in charge of an officer and render their verdict in the same manner as on the trial of an ordinary civil case. The testimony given shall be reported, all objections made and the rulings of the court thereon, the exceptions taken being noted by the regular court stenographer and the charge of the court or instructions given to the jury shall likewise be reported by him. The jury shall report in writing as to each distinct parcel of land and as to each street railroad company claimed to be damaged and the interests in the same separately, and when all is finished, bring the report into court, and the same shall be filed with the clerk. A disagreement of the jury as to one or more distinct parcels of land shall not affect their report as to any lands in regard to which they have agreed, and upon such disagreement the court may upon motion of the petitioner, with a view to further proceedings, permit the petition to be so amended as thereafter to relate only to the premises affected by such disagreement, and to the persons interested therein, and may also cause a new jury to be drawn and empaneled, which new jury shall be drawn and empaneled in the same manner as above provided for the drawing of the original jury, and like proceedings as above provided shall thereupon be had, as to the lands concerning which there was such failure to agree, and such new proceedings may be ordered by the court as often as may be necessary. The court may allow the jury to take with them when they retire proper descriptions of the land claimed to be damaged as well as maps of the same and of the premises adjacent thereto and showing the proposed improvement and such other papers as the court in its discretion may deem it proper for them to have, including forms of verdict containing a description of the property and the names of the occupants or owners or other persons interested therein, and in which they may find necessary to make the proposed improvement as aforesaid, or may not find it necessary to make such improvements, such forms to be made under the direction of the court, or the verdict may be prepared by the jury. The verdict of the jury may be set aside by the court and a new trial ordered for objections of law and for matters of substance, but not for objections as to matters of form, and in the same manner and on the same ground as an ordinary civil action in courts of general jurisdiction. The court may, before the jury is finally discharged, refer their verdicts and findings back to them, for the correction of any errors, defects or insufficiencies therein contained. The verdict of the jury shall be in writing and shall be signed by them.

§ 4244. Section 16. The jury shall in their verdict ascertain and determine the necessity for the separation of the grades of said street or highway, and of said railroad or railroads, as proposed in said petition. And if they find that such necessity exists they shall then ascertain and determine the amount of damages to such property as may be damaged

thereby, and also to any street railway so damaged, and shall award to the parties interested compensation for such damages. If any property damaged shall be subject to a mortgage or lease, or to any lien or estate or interest otherwise arising, they shall apportion the compensation awarded among the parties interested therein as they shall deem just. In case the owner of any interest in any property damaged is unknown, they shall determine the compensation for damages to such interest and the same shall be paid into court for the benefit of such persons. They shall state separately the several amounts of damages by them awarded, and any apportionment of damages among different interests by them made. The amount of cost and expense which it would be just and equitable that the city, county or township should pay to said railroad company or companies, for the doing and construction of the work to be done by it or them, and determined by said crossing board and stated in their report as provided by said section 9, and the amount of cost and expense which it would be just and equitable that said company or companies should pay to the city, county or township for the work to be done or constructed by the city, county or township, and determined by said crossing board and stated in their said report, shall be final and conclusive. And the said jury shall assess in their said verdict the total compensation by them awarded for damages for such property as may be damaged by such improvements to the parties interested therein and to any street railroad company, and also assess the amount determined by said report of the crossing board to be paid by said city, township or county, as its fair share of the expense of the work to be done said railroad company or companies, when the crossing is within the limits of the petitioner, against the petitioner, and in all other cases against the city, and county or counties, township or townships, as the case may be, that are parties to the proceedings in equal shares. Said last mentioned amount to be assessed in favor of and to be paid to said railroad company or companies. And they shall likewise assess against the said railroad company or companies and in favor of and to be paid to said city, county or township the portion of the cost or expense, which it was determined by said crossing board would be just and equitable, that said company or companies should pay to the petitioner or other body politic to whom the same are awarded in the report of said crossing board. Amendments either in form or substance may be allowed in any paper, petition, resolution, process, record or proceeding, or in the description of property damaged or claimed to be damaged, or in the name of any person whether contained in the resolution or certificate of the representative board or officer, in the petition of property owners or in the report of railroad and street crossing board or elsewhere, wherever the amendment will not interfere with the substantial rights of the parties. Any such amendment may be made after, as well as before the order confirming the verdict of the jury. Motions for a new trial or to arrest proceedings shall be made within two days after the rendition of the verdict unless further time is allowed by the court. And if no such motion is made, or if being made, is overruled, the court shall enter an order confirming the verdict of the jury, containing a recital of the substance of the proceedings and a description of each parcel of real estate for damages to which compensation is awarded, with the statement of the interest of any unknown party therein, and the name of each railroad company, street railroad company, municipality, or other party in interest in the proceedings to whom compensation for damages is awarded or to whom any of said costs or expense may be awarded or against whom the payment of any sum by said jury may be charged or assessed, which order shall also direct by whom, to whom, and in what time the payment of the sums awarded is to be made and said order of confirmation, unless reversed

by the Supreme Court, shall be final and conclusive as to all persons interested therein.

§ 4245. Section 17. Any party to said proceedings, considering himself aggrieved, may appeal from the order of the court confirming the verdict of the jury, by filing with the clerk of the court a written notice of such appeal within five days of the confirmation, and within the same time serving a copy thereof upon the attorneys of the adverse parties, and filing a bond in said court, to be approved by the judge thereof, conditioned for the prosecution of said appeal, to judment and payment of all costs, damages and expense that may be awarded against him in case the judgment of confirmation shall be affirmed. Such appeal shall be perfected within the same time and prosecuted in the same manner as appeals under the general act for taking private property for public use in cities and villages. In case of such an appeal the clerk of the court, on payment of his legal fees and charges, shall transmit to the Supreme Court a certified copy of the necessary files, records and proceedings in the case, and the judge of the court shall, at the request of the appellant, settle a case according to the usual practice of said court, showing the material evidence and instructions given to the jury bearing upon any disputed points to which exception is taken, and the objections, rulings and exceptions in the case, all of which shall be returned by said clerk as part of the records to the clerk of the Supreme Court.

§ 4246. Section 18. The said appeal may be brought on for a hearing at any term of the Supreme Court, and said court may affirm, or for any substantial error reverse the judgment, and may grant a new trial. The said court shall allow the prevailing party his reasonable costs and expenses to be taxed, and give judgment as in chancery appeals, and all costs, damages and expenses awarded to the city, township or county, if it so elect, may be applied on or deducted from the compensation, if any to be paid, or execution may issue on the judgment. Damages may be awarded against a party appealing without reasonable cause.

§ 4247. Section 19. The total compensation for damages and expenses, if fixed by agreement, settlement or compromise under the provisions of sections 2 and 3 of this Act, or if fixed by a jury, such total compensation less the total amount assessed against the railroad company or companies as hereinbefore provided, shall be paid by the city, township or county in whose name the proceedings are instituted, except in cases where some city, county or township is a party respondent, in which case it shall be paid by the city and county or counties, township or townships that are parties to the proceedings, as the case may be, in equal shares. Any sum assessed against any railroad company, as hereinbefore provided, shall be paid by such company to the petitioner.

§4248. Section 20. When the verdict of the jury shall have been finally confirmed by the court, and the time in which to take an appeal has expired, or if an appeal is taken on the filing in the court below of a certified copy of the order of the Supreme Court affirming the judgment of confirmation, it shall be the duty of the clerk of the court to transmit to the common council of the city, when a city was a party to the proceedings, and to the county clerk of each county, and to the township clerk of each township that was a party to said proceedings, a certified copy of the verdict and of the judgment of confirmation, and of the judgment, if any, of affirmance; and thereupon the proper and necessary proceedings in due course shall be taken for the collection of the sum or sums awarded by the jury.

§4249. Section 21. If the common council of any city which has been such party believe that either a portion of said city in the vicinity of the proposed separation of grades, or any street railroad company which

owns or operates a line, any part of which is within said city, and which was a party to such proceedings, or both such portion of the city, and any such company or companies will be especially benefited by such separation, they may, by an entry in their minutes, provisionally determine that the whole or any just proportion of that part of the compensation awarded for damages and expenses which is apportioned to said city, shall be assessed upon the owners or occupants of real estate, or upon such company or companies, or upon both such portion of the city and such company or companies deemed to be thus benefited; and thereupon they shall, by resolution, provisionally determine the district or portion of the city benefited, if any, and the amount to be assessed upon the owners or occupants of real estate therein, or upon said company or companies or upon both. The assessment district and the amount to be assessed having been thus provisionally determined, said common council shall fix a date for the hearing of persons objecting to the constitution of said assessment district, and to the amount to be assessed, and to the assessment of said company or companies, and shall cause a notice to be published once in each week, immediately preceding said hearing, for three successive weeks in a newspaper printed, published and circulated in the said city, or if there be no such paper, then in such newspaper printed and published in the state as said board shall deem to be most generally circulated in said city, which notice shall be substantially as follows: To (stating the name of all owners and occupants of real estate in said assessment district so far as known) and to all other persons owning and occupying or otherwise interested in the following described real estate (giving the description of all real estate in said district), and to (giving the names of the street railroad companies to be assessed, if any), you are hereby notified that the sum of —— dollars is the proportion of the amount of compensation awarded in consequence of the separation of grades of the street (or highway and railroad or railroads or any of these as the case may be), to be made at the intersection of (describing the intersecting street or highway and railroad or railroads by their names and in appropriate language) provisionally determined by the (giving name of the common council) to be assessed upon the above described real estate which has been provisionally constituted an assessment district therefor (upon said street railroad companies naming them, or upon both said companies and said real estate as the case may be). You will be given opportunity at the meeting of (giving name of said common council) to be held on ——, to show cause, if any there be, why any of the above described real estate should not be included in said assessment district, or (why said companies should not be assessed, or both, as the case may be), and why the amount to be assessed should not be fixed at the sum above stated.

Signed—(name of presiding officer of said common council).

§ 4250. Section 22. At the meeting of said common council designated in said notice, opportunity shall be given to said street railroad companies to show cause why they should not be assessed, and to any persons owning, occupying or otherwise interested in any real estate included in said assessment district, to show cause why their real estate should not be included in said district, and to said companies and to any persons so interested as aforesaid, opportunity to show cause why the amount to be assessed should not be fixed at the sum provisionally determined as aforesaid. Said common council shall, at the same meeting, or at any subsequent meeting to which the consideration of the matter may be adjourned, determine said assessment district, either as originally made or with the omission of such parcels of real estate as in their judgment should be omitted therefrom, and determine whether said companies shall or shall not be assessed; and shall at the same time determine the amount to be

assessed, either at the sum originally fixed or at such less sum as in their judgment shall be just, and such determination shall be final. The amount of benefit thus ascertained shall be assessed upon the owners or occupants of all the real estate in said assessment district which is not public property, and upon said companies, as follows: The assessing officers hereinafter referred to shall determine the amount of advantage acquired by each parcel of real estate not public property in said assessment district by reason of said separation of grades and the amount of advantage acquired by said street railroad company or by each of said companies, as the case may be, by reason of said separation of grades. They shall apportion and assess the total amount to be assessed upon all said lots and parcels of real estate in said district and upon said company or companies in proportion, as nearly as may be, to the relative amount of advantage by them so determined to be acquired by said several lots and parcels of land and by said company or companies. The amount thus apportioned and assessed to said company or companies they shall charge against it or them. The amount thus apportioned to said assessment district shall be assessed thereon, levied and collected in the same manner and by the same officers and proceedings, as near as may be, as is provided in the charter of the city for assessing, levying and collecting the expense of a public improvement when a street is graded.

§ 4251. Section 23. A certified statement of the amount of the assessment against any street railroad company, shall be transmitted by said city assessing officers to the clerk of the court in which said proceedings were had. Said clerk shall, on receiving such certified statement, make an entry thereof on the record of said proceedings, and such statement so entered shall operate as a payment pro rata of the amount of any award made to said company in said proceedings, and where such assessment was made by the officers of a city other than in whose name said proceedings were instituted, shall operate as a payment pro rata of the portion of the total compensation awarded in said proceedings, assessed therein against the city by whose officer such certified statement was made and transmitted. Said clerk shall send a certificate to the county treasurer or city treasurer of the city or county in whose name said proceedings were instituted, as the case may be, in all cases, stating whether the amount of assessments against such company is less than the amount of compensation so awarded to it, or is equal thereto, or is greater than the amount of said award, and stating the amount of the excess or deficiency, if any, as the case may be. Said clerk shall certify the total of the assessments against any such company, where no award was made to said company in said proceedings, or the excess, if any, of said total of said assessments over the amount of such award, where such award was made.

(a) In cases where said proceedings were instituted in the name of any city, to the receiver of taxes of said city or other officer by whom general taxes are collected.

(b) In cases where said proceedings are instituted in the name of any county, to the township treasurer of the township in which said crossing, or the part of said crossing within said county is situate: Provided, That if said crossing, or the part thereof within said counties lies in more than one township of said county, said certificate shall be made to the township treasurer of either of said townships.

(c) In cases where said proceedings are instituted in the name of any township, to the township treasurer of the township. The amount of the assessment so certified shall then be collected by the same officer, at the same time and in the same manner as general personal taxes are or may be collected, and shall, when collected by said collecting officers, be paid over to the treasurer of the city, county or township by which said pro-

ceedings were instituted, as the case may be, by whom it shall be placed to the credit of the fund created for the payment of the compensation on account of said changes of grade. Whether the amount of the assessments is greater than, equal to, or less than the amount of the award to said company, the treasurer of the city, county or township in whose name the proceedings were instituted shall, upon receiving certificate thereof, make an entry to that effect in the proper record, and when the fund for payment of compensation is provided, shall pay to said company the excess only of its award over said assessment.

§ 4252. Section 24. The assessment roll containing said assessments on a city district, when ratified and confirmed by the common council, shall be prima facie evidence of the regularity and legality of all proceedings prior thereto and up to and including said confirmation, and all assessments therein contained shall be and continue a lien on the premises against which the same are assessed, until payment thereof. Such part of the compensation apportioned as above provided, to any city for payment as is not raised in the manner hereinbefore provided, and all that part of the compensation which is apportioned, as above provided, to any county or township, shall be assessed, levied and collected on all taxable property of said city, county or township, as the case may be, in the same manner as general taxes are assessed and collected.

§4253. Section 25. As soon as may be after any agreement made under the provisions of section 2 of this act becomes enforceable, and as soon as may be after the final confirmation of any verdict in judicial proceedings under the provisions of this act, each city, county and township upon which, under the terms of such agreement, or of any settlement or compromise of damages made under the provisions of section 3 of this act, or of any such verdict the payment of any sum or sums of money is charged, shall set apart and cause to be provided in its treasury, unless already provided, its proportion of the amount required to pay all such sums, and shall, in the resolution setting apart and providing said amount, direct its treasurer to pay to the persons respectively entitled to the money so provided each his proportion thereof, as determined by said agreement, settlement, or verdict, except that in cases where the crossing is of either of the classes referred to in clauses (e) and (f) of section 1 of this act the proportion so provided by said bodies politic and corporate other than the one in whose name the said proceedings were instituted, less the amount of any assessments by any city made against any street railroad company or companies as hereinbefore provided, shall be paid over by the treasurers thereof, respectively, to the treasurer of said city, county or township in whose name the proceedings were instituted, to be by him credited to the fund provided for the payment of said awards of compensation, and disbursed by him to the parties entitled to said award. It shall be the duty of the treasurer securely to hold such money in the treasury for the purpose of paying said awards and to pay out the same to persons entitled thereto, according to the said verdict, on demand, and not to use or pay out said money for any other purposes whatever. Said cities, counties and townships may provide their respective proportions of said amount by borrowing from any other money or fund in their respective treasuries and repay such loan from the money raised to pay the compensation so awarded, when collected, or otherwise, as they may provide.

§ 4254. Section 26. The making of said separation of grades, whether in any railroad or in any street or highway, and of all other changes necessary to carry out the plan set forth in the resolution or certificate provided for by section 3, or in the report provided for in section 9, shall not be postponed or delayed on account of the non-payment of any of the the sums so awarded as compensation, nor shall the payment of any of the

sums so awarded as compensation be a condition precedent to the making of any said changes to carry out the said plan.

§ 4255. Section 27. As soon as may be after any agreement made under the provisions of section 2 of this act becomes enforceable, and as soon as may be after the confirmation of any verdict in judicial proceedings under this act, the separation of grades provided for either in the said agreement mentioned in section 2, or in the resolution, certificate or report attached to the petition provided for in section 11, as the case may be, shall be made and carried out in accordance with the plan, plat and profile set forth in said agreement, resolution, certificate or report. All changes of grades in any railroad or railroads and all changes in said railroad or railroads consequent on said separation of grades shall be made and carried out by the railroad company or companies operating the same. When, according to said plan of separation of grades, the street or highway will cross the railroad by an overhead bridge, the frame work of that part of said bridge within the side lines of the right of way and all abutments and supports sustaining that part of said bridge, shall be built, maintained and kept in repair by the railroad company, or, where such bridge crosses the right of way of more than one railroad company, by said companies. Where, according to said plan of separation of grades, the street or highway will pass under a railroad or railroads, the railroad bridge, its abutments and the sustaining walls along the highway within the side lines of its own right of way shall be built, maintained and kept in repair by each railroad company. The surface and approaches of such bridge over which the street or highway passes, and such public way under such railroad or railroads and the approaches thereto, shall be constructed, maintained and kept in repair by the township, county or city within which the same are situate, or, in the case of line crossings, by the joint action and under the joint supervision of the representative board or officer of the county or township, and of the persons or bodies in whom, by the charter of the city, the power to contract for and supervise the pavement of streets is vested, as the case may be. The expense of all work to be done by any railroad shall be paid by said railroad, or in case work is to be done by two or more railroads jointly, the expense shall be shared equally among them. The expense of all work to be done by any city, county or township shall be paid by such city, county or township, or in case work is to be done by a city and county or counties, township or townships, jointly, the expense shall be shared equally among them. Such expense imposed on any city, county or township shall be provided for by taxation in like manner as its other expenses are provided for.

§ 4256. Section 28. Said order of confirmation shall, after reciting the substance of the verdict, and declaring the same confirmed, provide that the several amounts therein assessed against the railroad company or companies and the several bodies politic and corporate, who are parties to the proceedings, shall be paid by them, respectively, within one year from the date of final confirmation, and that the change or changes of grade found to be necessary by said verdict shall be made by the parties on whom the duty of making them respectively is imposed, within such reasonable time as the court shall in said order determine, not exceeding one year from the date of said order. Such judgment shall have the force and effect of a decree in chancery and may be enforced by the court making the same, in any manner provided for the enforcement of chancery decrees.

§ 4257. Section 29. The officers, jurors and witnesses in any proceedings under this act shall be entitled to receive from the city, county or township instituting the proceedings, the same fees and compensation as are provided by law for similar services in an ordinary action at law in the Circuit Courts of the state.

§ 4258. Section 30. All the expenses and costs of proceedings under this act incurred by any municipality, county or township instituting the same, shall be paid out of the general fund, highway fund, or the fund provided for such purposes, as the case may be. It shall be lawful for the judge in any case to order the payment, by the city, county or township instituting the proceedings, to any respondent, of such reasonable attorney fee as he may deem just, not exceeding $25, which may be taxed with the other costs.

§ 4260. Section 32. It shall not be necessary in any proceedings under this act to give evidence in making out the prima facie case, of the party instituting the proceedings, of the ownership of interest of any of the respondents in any of the lands described in said petition as damaged or affected by said changes of grades, but the averments of said petition as to such matters shall, unless evidence is put in by the respondents contradictory thereof, be taken as true.

§ 4261. Section 33. In the city of Detroit the city counselor or other officer who may be the head of the legal department of said city shall perform the duties required by this act to be performed by the city attorney, and wherever the term city attorney shall be used herein, it shall as to and in said city be deemed to mean the city counselor or other head of the legal department.

MINNESOTA.

Any company operating a line of railroad in this state, and which company has failed or neglected to fence said road, and to erect and maintain such fence, crossings, and cattle-guards, shall be liable for all damages sustained by any person in consequence of such failure or neglect.

MISSISSIPPI.

Section 3546. Not to Run at a Rate Over Six Miles an Hour in Cities, Etc.; Damages For.—Any Railroad company, having the right of way, may run locomotives and cars, by steam, through cities, towns and villages, at the rate of six miles an hour, and no more; and if, in passing through any city, town or village, a locomotive or car should be run at a greater rate of speed, the company shall pay one hundred dollars, to be recovered by suit, in the name of the city, town or village, and for its use, and the company shall be liable for any damages or injury which may be sustained by anyone, from such locomotive or cars whilst they are running at a greater speed than six miles an hour through any city, town or village. (Amended, see Chapter 63, Acts 1896.)

The legislature can rightfully regulate the speed of trains in passing through cities, towns and villages; and the exercise of such power does not violate charter rights. Mobile R. R. Co. v. State, 51 Miss., 137.

Under the section, railroad company is liable for stock killed by its locomotives running in a town at a greater speed than six miles an hour, although the engine be checked when the animal is seen, and strike it when running at a less rate. New Orleans R. R. Co., v. Toulme, 59 Miss., 248.

If a locomotive be running through a city at a rate less than six miles an hour when animals jump into a trestle and render a collision inevitable, the speed may be increased, notwithstanding the law, in order to strike with such momentum as to knock them off and avoid throwing the train from the bridge. Chicago R. R. Co., v. Jones, 59 Miss., 465.

But it is no defense, of itself, that at the moment of collision the train was running less than six miles an hour. Illinois R. R. Co. v. Jordan, 63 Miss., 458.

This section does not embrace employes among those to whom a right of action is given. Dowell v. Vicksburg R. R. Co., 61 Miss., 519.

Section 3547. Bell and Whistle; When to Give Alarm, Etc.—Every railroad company shall cause each locomotive engine run by it to be provided with a bell of at least thirty pounds' weight, or a steam whistle, which can be heard distinctly at a distance of three hundred yards, and shall cause the bell to be rung, or the whistle to be blown, at the distance of at least three hundred yards from the place where the railroad crosses over any highway or street, and the bell shall be kept ringing, or the whistle shall be kept blowing, until the engine has stopped, or crosses the highway or street.

Section 3552. "Look Out for the Locomotive."—Every railroad company shall cause a board to be erected and kept up, upon a post or frame sufficiently high, at every place where the railroad may cross a highway, with this inscription, "Look Out for the Locomotive," or this, "Railroad Crossing." And, on failure to observe this, such company shall be liable to a fine of fifty dollars for each failure, and such an offense shall be cognizable before any justice of the peace of the county. A failure to erect the board, as directed, shall be deemed to have occurred once every day the company may continue so to fail or neglect to have the same set up after two days' notice to any agent or section master, and the company shall be liable to any party injured by such failure or neglect for all damages that he may have sustained thereby.

[The word "highway," as used in the section, means a public road in the country, not a street in a city, town or village. Mobile R. R. Co. v. State, 51 Miss., 137.]

Section 3555. Highway Crossings and Bridges.—Where a railroad is constructed, so as to cross a highway, and it be necessary to raise or lower the highway, it shall be the duty of the railroad company to make proper and easy grades in the highway, so that the railroad may be conveniently crossed, and to keep such crossing in good order; and it shall be the duty of the company to erect and keep in order all bridges on any highway, at such points as bridges may be necessary to cross the railroad; and any company which shall fail to comply with these provisions, shall forfeit the sum of one hundred dollars, to be recovered by an action in the name of the county in which the crossing or bridge is situated.

Section 3561. Stock-Gaps and Cattle-Guards.—It is the duty of every railroad company to construct and maintain all necessary or proper stock-gaps and cattle-guards where its track passes through enclosed land, and to make and maintain convenient and suitable crossings over its tracks for necessary plantation roads. For any failure so to do, the railroad company shall be liable to pay two hundred and fifty dollars, to be recovered by the person interested.

Section 4314. Gates Across Thoroughfares.—It is the duty of every road, whose track crosses a thoroughfare, whenever the commission shall declare the safety of the public to require it, and shall so order, to maintain a gate at the crossing thereof, and to close it during the passage of its engines and cars, and only for a sufficient length of time for that purpose. The commission may prescribe the materials, dimensions and mode of operation of such gates.

An Act to Enlarge the Powers of the Railroad Commission in Regard to Railway Crossings of Highways and Streets in Cities, Towns and Villages.—Section 1.—Be it enacted by the legislature of the state of Mississippi. That the railroad commissioners of this state are empowered, authorized and required to order any railroad company not to use for

switching purposes, nor for standing trains of any kind, such portions of its track upon or over any public street or highway in any city, town or village, as in their opinion the public convenience and safety require should not be used, and may limit the number of tracks, other than main tracks, which a railroad company may use upon or across such public street or highway for sidetrack or for switching purposes, and may order a railroad to remove such of the sidetracks or switching tracks now laid upon or across any such public street or highway as said commissioners may deem public convenience or safety require should be removed.

Section 2. That upon notice given of any order under the above section, made by the commissioners, the railroad company so notified shall within ninety days remove or adjust those tracks so as to comply with said order, and in default thereof shall forfeit and pay to the state of Mississippi one hundred dollars for each day's default, to be recovered by an action in the name of the state, to be prosecuted by said commissioners, and one-half of the amount recovered shall be paid to the city, town or village in which the default is made, and one-half into the treasury of the state, provided suit be brought within sixty days after default.

NEBRASKA.

Section 101.—Crossings.—Any railroad corporation may raise or lower any turnpike, plank road, or other way, for the purpose of having their railroad pass over or under the same; and in such cases said corporation shall put such turnpike, plank road, or other way, as soon as may be, in good repair.

Section 102.—Same.—Every railroad corporation, while employed in raising or lowering any turnpike or other way, or in making any other alterations, by means of which the said way may be obstructed, shall provide and keep in good order, suitable temporary ways to enable travelers to avoid or pass such obstructions.

Section 103.—Bridges.—Every railroad corporation shall maintain and keep in good repair all bridges, with their abutments, which such corporation shall construct, for the purpose of enabling their road to pass over or under any turnpike, road, canal, watercourse or other way.

Section 104.—Bell and Whistle.—A bell of at least thiry pounds' weight, or a steam whistle, shall be placed on each locomotive engine, and shall be rung or whistled at the distance of at least eighty rods from the place where the said railroad shall cross any other road or street, and be kept ringing or whistling until it shall have crossed said road or street, under a penalty of fifty dollars for every neglect, to be paid by the corporation owning the railroad, one-half thereof to go to the informer, and the other half to this state, and also be liable for all damages which shall be sustained by any person by reason of such neglect.

Section 105.—State Lands.—Any railroad corporation shall be authorized to pass over, occupy and enjoy, any of the school, university, saline or other lands of this state; provided, that no more than one hundred feet in width from the center of the roadway survey of such corporation, on either side, shall be taken for roadway, and not to exceed twenty acres, to conform to the subdivisions of the government survey, in any one tract for each section of twelve consecutive miles of such railroad, shall be taken for station, depot grounds, machine shops, turnouts, sidetracks, warehouses, and other appurtenances to a railroad; and that any railroad corporation that has surveyed or shall hereafter survey or locate a line of its road, immediately upon platting such survey

of its line, and of the selection for depot grounds under this act, and filing such plat duly certified by the chief engineer or president of such corporation, of the fact of such survey and selection for depot grounds, duly acknowledged, with the secretary of state, and with the county clerk of the county in which such land is situated, to operate as a vested right in such corporation for two years from the date of filing the same, shall be authorized to enter upon said lands so surveyed and selected, and construct thereon all necessary railroad depot buildings, machine shops, turn-outs, side-tracks, turntables, roundhouses and other appurtenances deemed necessary for railroad purposes by such corporation, and so soon as such railroad shall be constructed over such lands, so selected, and a station erected thereon, on proof of such fact, to the satisfaction of the governor, and upon paying the full value for said lands for depot station and workshop grounds, and all grounds herein contemplated, except the one hundred feet of trackway, the governor shall convey in fee simple by letters patent under the great seal of the state, attested by the secretary of state, to the corporation constructing such railroad, the lands and right of way included in the plat and certificate so filed with the secretary of state, as aforesaid, and no subsequent grant from the state to any other person or corporation of any tract of land including such right of way and selection for depot grounds so platted, and the plat thereof filed as aforesaid, though not excepted in such grant, shall divest said railroad corporation of their rights in the same under this act; provided, further, that the damages accruing to any occupant or owner, or other person who may reside or have improvements on said land previous to the filing of such plat, shall be determined and paid by said railroad company, as heretofore provided in this subdivision.

Section 106.—Crossings Where Persons Own Land on Both Sides.—When any person owns land on both sides of any railroad, the corporation owning such railroad shall, when required so to do, make and keep in good repair one causeway or other adequate means of crossing the same.

NEW HAMPSHIRE.

Railroads cannot occupy a grade crossing over a highway more than five minutes at one time, without authority from the board of railroad commissioners; and the railroad commissioners are authorized to fix a maximum time, not exceeding nine minutes. The engineer of every locomotive drawing a passenger train, when approaching a grade crossing over another railroad at which no signal man is stationed, must stop his train at least 500 feet from the crossing, and shall then proceed slowly over the crossing, but one stop is sufficient for all such crossings located within 600 feet of each other upon the same railroad.

No street railway shall permit its cars to cross the track of a steam railroad without coming to a full stop not more than 75 feet, nor less than 20 feet from the crossing, and before attempting to cross the driver must carefully examine for approaching trains, and shall not proceed to cross until he has ascertained that his car may cross with safety. No railroad hereafter constructed can cross another railroad, highway or other way, at grade without the consent in writing of the board of railway commissioners. No street railway shall lay its tracks across the tracks of a steam railroad, and no steam railroad shall lay its track across the tracks of a street railway, without the consent in writing of the railroad commissioners, who are authorized to make such orders, rules and regulations for the protection of persons from injury at such crossings as they may deem sufficient and necessary.

The board of railroad commissioners are also authorized, upon petition and due notice, and hearing, to empower railroads to raise or lower a highway or other way where it is crossed by a railroad, for the purpose of having it pass above or below the railroad, and for the purpose of separating the grade of the two roads. They may also, upon like proceeding, empower the proprietor of a railroad to change the location of a highway or other way, for the purpose of avoiding or improving a crossing of a highway by the railroad, or enabling them to properly construct their railroad.

Towns may require the proprietors of a railroad to raise or lower a highway where it is crossed by a railroad so that it will be sufficiently above or below the railroad to safely accommodate the travel upon both, or to erect and maintain gates across a highway by the side of the railroad, or to station a flagman there. If the proprietors do not comply with such a vote within six months after receiving a copy of it, they forfeit $100 for each month's neglect, unless an appeal is taken to the railroad commissioners from the action of the town. This may be done within sixty days after receiving a copy of the vote; and the commissioners, after notice and hearing, and examining the crossing, shall make such an order in respect thereto as the public good requires. If the proprietors fail to comply with such an order, they may be fined not exceeding $1,000.

If the owner of land and the proprietors of a railroad cannot agree upon the place, number or kind of cattle-guards, passes or crossings to be constructed for his accommodation, the matter may be settled by the railroad commissioners upon petition, notice and hearing.

NEW JERSEY.

Section 29. Bell on Locomotive to Be Run at Street and Railroad Crossings.—A bell shall be placed on each locomotive engine and rung at the distance of at least eighty rods from the place where the railroad shall cross any traveled public road or street, and be kept ringing until it shall have crossed such road or street; or a steam whistle shall be attached to each locomotive engine and be sounded at least eighty rods from the place where the railroad shall cross any such road or street, except in cities, and be sounded at intervals until it shall have crossed such road or street, under a penalty of twenty dollars for every neglect of the provisions of this section, to be paid by the corporation owning the railroad, to be sued for by any informer within ten days after such penalty was incurred; one-half thereof to go to the informer and the other half to go to the county; and said corporation shall also be liable for all damages which shall be sustained by any person by reason of such neglect.

Section 30. Sign Boards to Be Erected.—Every such corporation shall cause boards to be placed, well supported by posts or otherwise, and constantly maintained across each traveled public road or street, where the same is crossed by the railroad on the same level; said boards shall be elevated so as not to obstruct the travel and to be easily seen by travelers; and on each side of said boards shall be painted in capital letters, of at least the size of nine inches each, the words "Look out for the locomotive;" but this section shall not apply to streets in cities or villages, unless the corporation shall be required to put up such boards by the officers having charge of such streets.

Section 32. Fences to Be Kept Up and Maintained and Cattle-guards at Road Crossings.—Every corporation formed under this act shall erect and maintain fences on the sides of their road, of the height

and strength of a division fence required by law, with openings or gates or bars therein, and farm crossings of the road for the use of proprietors of lands adjoining such railroad; and also construct and maintain cattle-guards at all road crossings suitable and sufficient to prevent cattle and animals from getting onto the railroad; until such fences and cattle-guards shall be duly made, the corporation and its agents shall be liable for all damages which shall be done by their agent or engines to cattle, horses or other animals thereon; and after such fences and guards shall be duly made and maintained, the corporation shall not be liable for any such damages, unless negligently or wilfully done; and if any person shall ride, lead or drive any horse or other animal upon such road, and within such fences and guards other than at farm crossings, and without the consent of the corporation, he shall, for every such offense, forfeit a sum not exceeding ten dollars, and shall also pay all damages which shall be sustained thereby to the party aggrieved; it shall not be lawful for any person other than those connected with or employed upon the railroad, to walk along the track or tracks of any railroad, except where the same shall be laid along public roads or streets.

Section 47. Company May Construct Railroad Over Certain Portion of Street or Highway.—In addition to the powers granted under the act to which this is a supplement, any railroad company incorporated under the act to which this is a supplement and any supplements or amendments thereto, shall have power to construct its railroad so as to cross any portion of any street or highway in any municipality, the land for which portion has been taken for a street by condemnation under proceedings had under the charter of such municipality, and which portion of said street or highway has been, or at the time of the construction of said railroad shall have been laid on land which was under tidewater in the year 1864, when the first riparian act was passed; the right to cross such street or highway to be either on a level with the actual or established grade of such street or highway, or at such distance above or below such actual or established grade, as in the judgment of the municipal body or bodies hereinafter referred to may be best adapted to secure the safety of lives and property, or promote the interests of such municipality; provided, that the board of aldermen, common council, or other similar governing body in such municipality shall, by ordinance, authorize the construction of such railroad across the street or highway in such municipality, and make such provision or condition concerning the same as to such board of aldermen, common council or other similar governing body may seem fit, desirable and necessary; and whenever such permission shall be given, the said board of aldermen, common council, or other similar governing body, shall have power, by like ordinance, to vacate the portion of such street or highway crossed by said railroad as aforesaid, and such additional portion of such street or highway adjacent thereto as may lie between the next intersecting lines of public highways on either side of such part of said street so crossed by said railroad as aforesaid, or between the next intersecting line of a public highway on the one side and the end of said street nearest said railroad; provided, that any navigable basin or natural waterway, subject to the right of public navigation, shall be deemed and treated as a public highway for the purpose only of defining the limit of vacation under this act; and provided, further, that said railroad company shall pay to such municipality the actual amount expended by said city for all improvements of the part of the street so vacated, including the amount paid by such municipality for the land taken by such municipality under proceedings to condemn said land

for a public street or highway, or such part of the amount so expended as has not been otherwise repaid to said municipality.

Section 48. Erection of Piers for Bridge in Street.—It shall be lawful for any railroad corporation chartered under the act to which this is a supplement, which shall in the construction of their railroad cross any street or public highway above grade by a bridge, under the authority of the act to which this is a supplement, to erect piers for the support and safety of such bridge, if the same shall by them be deemed advisable, which piers may be located at the outer edge of the wagon-way so as not to encroach thereon, and extended thence into the sidewalk, or space left therefor; provided, that from their lands on each side of said road or street so much shall be added to the sidewalk on that side and thrown open to public use for such purpose as shall be occupied by the pier on that side.

In all instances such bridges shall be erected at sufficient elevation so as not to prevent or impede the use of such roads or highways for ordinary travel.

Section 53. Freeholders Authorized to Build Bridges over Railroads, Etc., Upon Petition.—Where any railroad shall cross at least eight feet below grade any street in any city in this state, and said street where the same is crossed by any such railroad shall have been dedicated and shall have been wholly or in part opened or improved subsequent to the building of such railroad, and by reason of such railroad cut or crossing it shall be necessary to construct a bridge across said railroad, cut or crossing for the convenience of public travel over any such street, and for the purpose of making such street a continuous highway, it shall be lawful for, and the board of chosen freeholders of any county in this state in which any city containing such street is situated is hereby authorized and empowered to construct and maintain a proper bridge across any such railroad, cut or crossing, together with suitable abutments to connect the termini of any such street on either side of such railroad, cut or crossing, upon petition therefor, presented or to be presented to any such board, which petition shall be signed by the owners of at least one-third of the property within a radius of five hundred feet each side along the line of any such street.

Section 56. Municipal Authorities of Cities Authorized to Contract with Railroad Companies.—The proper municipal authorities respectively of any city of this state be and they are hereby authorized and empowered to enter into such contracts with any of the railroad companies whose roads now or hereafter may enter or lie within their cities, respectively, or whose routes have been or may be located therein, as shall secure greater safety to persons and property therein, or facilitate the construction and maintenance of other than grade crossings of streets, highways, or other railroads therein, whereby the said railroad companies, or any of them, may locate, relocate, change, alter grades of, depress or elevate their railroads within said cities, or either of them, as in the judgment of such municipal authorities respectively may be best adapted to secure the safety of lives and property, or to provide for other than grade crossings of streets or highways or of other railroads therein, or to promote the interests of said cities respectively, and for that purpose shall have power to open, vacate, alter the lines and change the grades of any streets or highways or any part thereof, within said cities or either of them, and to do all such acts as may be necessary and proper to effectually carry out such contracts; and any such contracts made by any railroad company or companies, as aforesaid, with said cities or either of them are hereby fully authorized, ratified and confirmed.

Section 331. Unlawful to Lay Out or Locate a Public Road Across Railroads Within Five Hundred Feet of Other Public Road.—Where any public road crosses the roadbed and tracks of any railroad company in this state, it shall not be lawful for the surveyors of the highways, or other body having the power to lay out or vacate public roads in this state, to lay out or locate a public road across such railroad and tracks, within a distance of five hundred feet of such other public road or crossing; provided, that this act shall not apply to incorporated cities.

NEW YORK.

An Act to amend railroad law, and the act amendatory thereof, relative to grade crossings.

Section 1. Article 2, of chapter 565, of the laws of 1890, entitled "An Act in relation to railroads, constituting chapter 39 of the general laws," known as the railroad law, as amended by chapter 676 of the laws of 1892, is hereby amended by adding thereto the following sections:

§ 60. All steam surface railroads, hereafter built, except additional switches and sidings, must be so constructed as to avoid all public crossings at grade, whenever practicable so to do. Whenever application is made to the board of railroad commissioners, under section 59 of the railroad law, there shall be filed with said board a map showing the streets, avenues and highways proposed to be crossed by the new construction, and the said board shall determine whether such crossings shall be under or over the proposed railroad, except where said board shall determine such method of crossing to be impracticable. Whenever an application is made under this section to determine the manner of crossing, the said board shall designate a time and place when and where a hearing will be given to such railroad company, and shall notify the municipal corporation having jurisdiction over such streets, avenues or highways proposed to be crossed by the new railroad. The said board shall also give public notice of such hearing in at least two newspapers, published in the locality affected by the application, and all persons owning land in the vicinity of the proposed crossings shall have the right to be heard. The decision of the said board rendered in any proceedings under this section shall be communicated, within 20 days after final hearing, to all parties to whom notice of the hearing in said proceedings was given, or who appeared at said hearing by counsel or in person.

§ 61. When a new street, avenue or highway, or new portion of a street, avenue or highway, shall hereafter be constructed across a steam surface railroad, other than pursuant to the provisions of section 62 of this Act, such street, avenue or highway, or portion of such street, avenue or highway, shall pass over or under such railroad or at grade, as the board of railroad commissioners shall direct. Notice of intention to lay out such street, avenue or highway, or new portion of a street, avenue or highway, across a steam surface railroad, shall be given to such railroad company by the municipal corporation at least 15 days prior to the making of the order laying out such street, avenue or highway by service personally on the president or vice-president of the railroad corporation, or any general officer thereof. Such notice shall designate the time and place and when and where a hearing will be given to such railroad company, and such railroad company shall have the right to be heard before the authorities of such municipal corporation upon the question of the necessity of such street, avenue or highway. If the municipal corporation determines such street, avenue or highway to be necessary, it shall then apply to the board of railroad commissioners before any further proceedings are taken, to determine whether such street, avenue or high-

way shall pass over or under such railroad, or at grade, whereupon the said board of railroad commissioners shall appoint a time or place for hearing such application, and shall give such notice thereof, as they judge reasonable, not, however, less than 10 days, to the railroad company whose railroad is to be crossed by such new street, avenue or highway, or new portion of a street, avenue or highway, to the municipal corporation and to the owners of land adjoining the railroad and that part of the street, avenue or highway to be opened or extended. The said board of railroad commissioners shall determine whether such street, avenue or highway, or new portion of a street, avenue or highway, shall be constructed over or under such railroad or at grade; and if said board determine that such street, avenue or highway shall be carried across such railroad above grade, then said board shall determine the height, the length and the material of the bridge or structure by means of which such street, avenue or highway shall be carried across such railroad, and the length, character and grades of the approaches thereto; and if said board shall determine that such street, avenue or highway shall be constructed or extended below the grade, said board shall determine the manner and method in which the same shall be so carried under, and the grade or grades thereof, and if said board shall determine that said street, avenue or highway shall be constructed or extended at grade, said board shall determine the manner and method in which the same shall be carried over said railroad at grade and what safeguards shall be maintained. The decision of the said board as to the manner and method of carrying such new street, avenue or highway, or new portion of a street, avenue or highway, across such railroad, shall be final, subject, however, to the right of appeal hereinafter given. The decision of said board rendered in any proceeding under this section shall be communicated within 20 days after final hearing to all parties to whom notice of the hearing in such proceeding was given or who appeared at such hearing by counsel or in person.

§ 62. The mayor and common council of any city, the president and trustees of any village, the town board of any town within which a street, avenue or highway crosses or is crossed by a steam surface railroad at grade, or any steam surface railroad company, whose road crosses or is crossed by a street, avenue or highway at grade, may bring their petition, in writing, to the board of railroad commissioners, therein alleging that public safety requires an alteration in the manner of such crossing, its approaches, the method of crossing, the location of the highway or crossing, the closing and discontinuance of a highway crossing and the diversion of the travel thereon to another highway or crossing, or if not practicable to change such crossing from grade or to close and discontinue the same, the opening of an additional crossing for the partial diversion of travel from the grade crossing, and praying that the same may be ordered; whereupon the said board of railroad commissioners shall appoint a time and place for hearing the petition, and shall give such personal notice thereof as they shall judge reasonable, of not less than 10 days, however, to said petitioner, the railroad company, the municipality, in which such crossing is situated, and to the owners of the lands adjoining such crossing and adjoining that part of the highway to be changed in grade or location, or the land to be opened for a new crossing, and shall cause notice of said hearing to be advertised in at least two newspapers published in the locality affected by the application; and after such notice of hearing the said board of railroad commissioners shall determine what alterations or changes, if any, shall be made. The decision of said board of railroad commissioners rendered in any proceeding under this section, shall be communicated

within 20 days after final hearing to all parties to whom notice of the hearing in said proceeding was given, or who appeared at said hearing by counsel or in person. Any person aggrieved by such decision, or by a decision made pursuant to sections 60 and 61 hereof, and who was a party to said proceeding, may within 60 days appeal therefrom to the appellate division of the Supreme Court in the department in which such grade crossing is situated and to the Court of Appeals, in the same manner and with effect as is provided in the case of appeals from an order of the Supreme Court.

§ 63. The municipal corporation in which the highway crossing is located, may, with the approval of the railroad company, acquire by purchase any lands, rights or easements necessary or required for the purpose of carrying out the provisions of sections 60, 61 and 62 of this Act, but if unable to do so shall acquire such lands, rights or easements by condemnation either under the condemnation law, or under the provisions of the charter of such municipal corporation. The railroad company shall have notice of such proceedings and the right to be heard therein.

§ 64. When a highway crosses a railroad by an overhead bridge, the framework of the bridge and its abutments shall be maintained and kept in repair by the railroad company, and the roadway thereover and the approaches thereto shall be maintained and kept in repair by the municipality in which the same are situated. When a highway passes under a railroad, the bridge and its abutments shall be maintained and kept in repair by the railroad company, and the subway and its approaches shall be maintained and kept in repair by the municipality in which the same are situated.

§ 65. Whenever, under the provisions of section 60 of this Act, new railroads are constructed across existing highways, the expense of crossing above or below the grade of the highway shall be paid entirely by the railroad corporations. Whenever under the provisions of section 61 of this act a new street, avenue or highway is constructed across an existing railroad, the railroad corporation shall pay one-half and the municipal corporation wherein such street, avenue or highway is located shall pay the remaining one-half of the expense of making such crossing above or below grade; and whenever a change is made as to an existing crossing in accordance with the provisions of section 62 of this Act, 50 per centum of the expense thereof shall be borne by the railroad corporation, 25 per centum by the municipal corporation and 25 per centum by the state. Whenever, in carrying out the provisions of sections 61 or 62 of this act, two or more lines of steam surface railroad, owned and operated by different corporations, cross a highway at a point where a change in grade is made, each corporation shall pay such proportion of 50 per centum of the expense thereof as shall be determined by the board of railroad commissioners. In carrying out the provisions of sections 60, 61 and 62 of this Act the work shall be done by the railroad corporation or corporations affected thereby, subject to the supervision of and approval of the board of railroad commissioners, and in all cases, except where the entire expense is paid by the railroad corporation, the expense of construction shall be paid primarily by the railroad company, and the expense of acquiring additional lands, rights or easements, shall be paid primarily by the municipal corporation wherein such highway crossings are located. Plans and specifications of all changes proposed under sections 61 and 62 of this Act, and an estimate of the expense thereof shall be submitted to the board of railroad commissioners for their approval before the letting of any contract. In case the work is done by contract the proposals of contractors shall be submitted to the board of railroad commissioners, and if the board shall determine that the bids are

excessive it shall have the power to require the submission of new proposals. The board of railroad commissioners may employ temporarily such experts and engineers as may be necessary to properly supervise any work that may be undertaken under sections 60, 61 or 62 of this Act, the expense thereof to be paid by the comptroller upon the requisition and certificate of the said board, said expense to be included in the cost of the particular change in grade on account of which it is incurred and finally apportioned in the manner provided in this section. Upon the completion of the work and its approval by the board of railroad commissioners an accounting shall be had between the railroad corporation and the municipal corporation, of the amounts expended by each with interest, and if it shall appear that the railroad corporation or the municipal corporation have expended more than their proportion of the expense of the crossing as herein provided, a settlement shall be forthwith made in accordance with the provisions of this section. All items of expenditure shall be verified under oath, and in case of a dispute between the railroad corporation and the municipal corporation as to the amount expended, any judge of the Supreme Court in the judicial district in which the municipality is situated, may appoint a referee to take testimony as to the amount expended, and the confirmation of the report of the referee shall be final. In the event of the failure or refusal of the railroad corporation to pay its proportion of the expense, the same, with interest from the date of such accounting, may be levied and assessed upon the railroad corporation and collected in the same manner that taxes and assessments are now collected by the municipal corporation within which the work is done; and in the event of the failure or refusal of the municipal corporation to pay its proportion of the expense, suit may be instituted by the railroad corporation for the collection of the same with interest from the date of such accounting, or the railroad corporation may offset such amount with interest against any taxes levied or assessed against it or its property by such municipal corporation. The legislature shall annually appropriate out of any moneys not otherwise appropriated the sum of $100,000 for the purpose of paying the state's proportion of the expense of a change in an existing grade crossing. If, in any year, any less sum than $100,000 is expended by the state for the purpose aforesaid the balance remaining unexpended shall be applied to reduce the amount appropriated by the state in the next succeeding year, except that no such deduction shall be made in case there are outstanding and unadjusted obligations on account of a change in an existing grade crossing for a proportion of which the state is liable under the provisions of this section. In the event of the appropriation made by the state in any one year being insufficient to pay the state's proportion of the expense of any change that may be ordered the first payment from the appropriation of the succeeding year shall be on account of said change, and no payment shall be made on account of any subsequent change that may be ordered, nor shall any subsequent change be ordered until the obligation of the state on account of the first-named change in grade has been fully discharged, unless the same shall be provided for by an additional appropration to be made by the legislature. The state's proportion of the expense of changing any existing grade crossing shall be paid by the state treasurer on the warrant of the comptroller, to which shall be appended the certificate of the board of railroad commissioners to the effect that the work has been properly performed and a statement showing the situation of the crossing that has been changed, the total cost and the proportionate expense thereof, and the money shall be paid in whole or in part to the railroad corporation or to the municipal corporation as the board of railroad commissioners may direct, subject,

however, to the rights of the respective parties as they appear from the accounting to be had as hereinbefore provided for.

§ 66. The railroad commissioners may, in the absence of any application therefor, when, in their opinion, public safety requires an alteration in an existing grade crossing, institute proceedings on their own motion for an alteration in such grade crossing, upon such notice as they shall deem reasonable, of not less than 10 days, however, to the railroad company, the municipal corporation and the person or persons interested, and proceedings shall be conducted as provided in section 62 of this Act. The changes in existing grade crossings authorized or required by the board of railroad commissioners in any one year shall be so distributed and apportioned over and among the railroads and the municipalities of the state as to produce such equality of burden upon them for their proportionate part of the expenses as herein provided for, as the nature and circumstances of the cases before them will permit.

§ 67. It shall be the duty of the corporation, municipality or person or persons to whom the decisions or recommendations of the board of railroad commissioners are directed, as provided in sections 60, 61, 62 and 66 of this Act, to comply with such decisions and recommendations, and in case of their failure so to do, the board shall present the facts in the case to the attorney-general, who shall thereupon take proceedings to compel obedience to the decisions and recommendations of the board of railroad commissioners. The Supreme Court, at a special term, shall have the power in all cases of such decisions and recommendations by the board of railroad commissioners to compel compliance therewith by mandamus, subject to appeal to the appellate division of the Supreme Court and the Court of Appeals, in the same manner, and with like effect, as is provided in case of appeals from any order of the Supreme Court.

NORTH CAROLINA.

Railroad companies are required to erect and maintain in good and safe condition good and sufficient cattle-guards at the point of entrance upon and exit from enclosed land, and also make and keep in constant repair crossings to any plantation road thereupon.

There is no statute requiring the sounding of bell or whistle on approaching road crossings, but failure to do so is held by the courts to be negligence.

Whenever the track of a railroad shall cross a highway, turnpike or plank road, such highway, turnpike, or plank road may be carried under or over the track, as may be found most expedient; and in cases where an embankment or cutting shall make a change in the line of such highway, turnpike or plank road desirable, the railroad company may take such additional land for the construction of such highway, turnpike or plank road as may be deemed requisite.

Railroad companies are required to maintain at their own expense all bridges on or over county or incorporated roads made necessary in establishing their road.

NEVADA.

Where one railroad desires to cross another, such crossing may be either over or under, this matter to be determined by the railroad companies interested. No other legislation in regard to highway grade crossings.

NORTH DAKOTA.

Section 2947. Powers.—Every corporation formed under this article and every railroad corporation authorized to construct, operate or maintain a railroad within this state shall have * * * the following powers:

5. Subject to the provisions of section 2956, to construct its railroad across, along or upon any stream of water, watercourse, street, highway, toll or wagon road, plank road, turnpike, wharf, levee, river front, steamboat or other public landing or canal, which its route shall intersect or touch; to carry any highway, street, toll or wagon road, plank road or turnpike which it shall touch, intersect or cross over or under its tracks, as may be most expedient for the public good; to change the course or direction of any highway, street, turnpike, toll or wagon road, or plank road, when made necessary or desirable, to secure more easy ascent or descent by reason of any embankment or cut made in the construction of the railroad and take land necessary therefor; provided, such highway or road is not so changed from its original course more than 6 rods, nor its distance thereby lengthened more than 5 rods.

Section 2955. Highways, Etc., to Be Restored to Former State.—Every corporation constructing, owning or using a railroad shall restore every stream of water, watercourse, street, highway, plank road, toll or wagon road, turnpike or canal across, along or upon which such railroad may be constructed to its former state or to such condition as that its usefulness shall not be materially impaired, and thereafter maintain the same in such condition against any effects in any manner produced by such railroad.

Section 2956. Clear Passage Over Highways.—When it shall be necessary in the construction of a railroad to erect a bridge or culvert over any highway, street, turnpike, or plank road, toll or wagon road, it shall be sufficient to construct the same so as to give a clear passage way of 20 feet or two passage ways of 14 feet each.

Section 2979. Crossing When Land on Both Sides Owned by One Person.—When any person owns land on both sides of any railroad the corporation owning such railroad shall, when required so to do, make and keep in good repair one causeway or other safe and adequate means of crossing the same.

Section 3000. To Maintain Sufficient Crossings.—All railway companies operating a line of railway in this state shall build or cause to be built and kept in repair good and sufficient crossings over such line at all points where any public highway in use is now or may hereafter be intersected by the same.

Section 3001. How to be Constructed.—Such crossing shall be constructed as follows:

1. Of a grade of earth on one or both sides of the railroad track as the location may require 20 feet in width, the middle point of which shall be as nearly as practicable at the middle point of the highway and such grade shall be of such slope as shall be necessary for the safety and convenience of the traveling public.

2. Plank shall be firmly spiked on and for the full length of the ties used in the roadbed of such railway where such crossing occurs and shall be laid not more than 1 inch apart, except where the rail prevents; the plank next inside of the rail shall not be more than 2½ inches from the inside surface of such rail and the plank used in the crossing shall not be less than 3 inches in thickness and so laid that the upper surface of the plank shall be on a level with the upper surface of the rail; such plank shall extend along the railway the entire width of the highway grade and in no case less than 20 feet.

OHIO.

Section 247a. When in the opinion of the commissioner of railroads, the public safety requires that a gate or gates, automatic alarm, bell or other mechanical device, be erected and maintained at a place where a public road or street is crossed at the same level by any railroad, and which crossing has been declared by said commissioner to be a dangerous one, or that a flagman be stationed and maintained at such dangerous crossing, he shall give the superintendent, manager, or other officer in charge of such railroad, a written notice that the same is required, and such company, person or corporation owning or operating such railroad shall erect or station the same within such time thereafter as said commissioner shall prescribe. Any company, person or corporation neglecting or refusing to erect or maintain such gate or gates, automatic alarm bell or other mechanical device, or to maintain such flagman, when so required as aforesaid, shall forfeit and pay to the state, for every such neglect or refusal, the sum of $100, and the further sum of $10 for every day while such neglect or refusal shall continue.

Section 247b. All gates, bells or devices, which by the provisions of this Act are under the direction of the commissioner of railroads, shall be built in such a manner, and within such a time, and of such material as shall be approved by the commissioners of railroads, and shall be located on the highway or street, on one or both sides of the railroad track or tracks, as the commissioner may deem the public safety to require, and shall be so constructed as, when closed, to obstruct and prevent any passage across such railroad or railroads from the side on which the gate may be located; or said bell shall be made to ring before the approach of each and every train of cars or of a locomotive within 300 feet of such crossing, or more, according to the speed of the train, and continue to ring until the train of cars or the locomotive shall have reached the crossing. There shall be a person in charge of every such gate, and it shall be his duty to close the same at the approach of every train of cars, or of a locomotive, and to keep it open at all other times. In case an automatic alarm bell, or other mechanical device shall be required at any such crossing, it shall be the duty of the railroad company at all times to keep such bell or device in good working order. For every neglect of such duty such person or railroad company, upon conviction thereof, shall pay the sum of $25. When more than one railroad crosses a public highway or street at such dangerous crossing, the expense incurred in the erection and maintenance of gates, bells or device provided for in this section, and of the necessary gatekeepers, or of a flagman, shall be shared equally by the railroad companies alongside whose tracks the gates, bells or device shall be located. Provided, that an automatic alarm bell, or other mechanical device, as provided for in this and the preceding section, shall not be erected within the limits of any city of the first class or of any city of the first, second, third and fourth grades of the second class, upon the order of the commissioner of railroads and telegraphs; but nothing herein contained shall prohibit any railroad company from using such automatic alarm bell or other mechanical device, if it desire, at any public railroad crossing not declared dangerous by said commissioner of railroads and telegraphs; and, provided, further, that where a gate or gates has or have been erected, and is or are maintained, by the railroad company, or where a flagman has been stationed and is maintained by the railroad company, shall not be abandoned, and any automatic alarm bell or other mechanical device substituted therefor.

Section 247c. When in the opinion of the city council of any city of the third grade b of the second class, the public safety requires that a gate or gates be erected and maintained at any place where a public road or street is crossed in said city at the same level by any railroad, and which crossing has been declared by said council to be a dangerous one, or that a flagman be stationed and maintained at such dangerous crossing, council shall give the superintendent, manager or other officer in charge of such railroad, a written notice that the same is required, and such company, person or corporation owning or operating such railroad shall erect or station the same within such time thereafter as council may prescribe. After said notice has been given to the superintendent, manager or other officer in charge of such railroad that the same is required, such railroad company and said council shall agree as to whether said crossing so declared to be dangerous shall be protected by a gate or gates, or a flagman, and if they fail to come to any agreement within 10 days, then the question shall be submitted to arbitrators, the council selecting one person, the railroad company one; the two thus selected shall choose a third. The arbitrators thus selected shall decide whether said dangerous crossing shall be protected by a gate or gates, or a flagman, and their decision shall be final. Any company, person or corporation neglecting or refusing to erect or maintain such gate or gates, or to maintain such flagman when so required as aforesaid, shall forfeit and pay to the state for every such neglect or refusal the sum of $100, and the further sum of $10 for every day while such neglect or refusal shall continue. Provided, further, that nothing herein contained shall be construed as conflicting with section 247a.

Section 2494. When it is deemed necessary by the council of any city or village to have any bridge or railway, located in whole or in part in such corporation, owned, possessed, or operated by any individual, company, association, or corporation, or any portion of the same, lighted, the council shall pass an ordinance, for that purpose, requiring the individual, company, association, or corporation owning, possessing, or operating the same, to light such bridge or railway within a specified time.

Section 2495. The ordinance shall specify the manner in which such bridge or railway shall be lighted, the number and style of lamp posts, gas posts, electric lights or other lights and fixtures and the time such lights shall be kept burning in each 24 hours.

Section 2496. Notice of such requirement to light any bridge or railway shall be given at least 20 days before any penalty or charge shall be imposed for default; and such notice may be given by delivering to any owner or part owner, or any person having possession, charge or management of such bridge or railway, a written or printed copy of the ordinance.

Section 2497. If the person, company, or corporation, owning, possessing, or operating such railway or bridge, neglect or fail to do such lighting in conformity with the provisions of the ordinance for 20 days after notice as aforesaid, the council may immediately proceed to cause the lighting to be done at the expense of such person or persons, company, or corporation.

Section 2498. The council may direct the manner in which the expense of lighting such bridge or railway shall be assessed and collected, and when assessed, the amount shall be a debt due against and payable by such person, company or corporation, and shall be a lien to be enforced as any other lien on such bridge and the land on which the same is built, or upon the real estate of the railway company or leasehold interest situate or being within the county wherein such city or village is located.

Section 2499. The charge may be collected or the lien enforced in the manner pointed out in the chapter providing for the assessment of damages and expenses for making public improvements.

Section 3277. For the purpose of avoiding annoyance to public travel, or dangerous or difficult curves or grades, or unsafe or unsubstantial grounds or foundations, or when the roadbed has been injured or destroyed by the current of any river, watercourse, or other unavoidable cause, or for reasonable cause. a company may change the location or grade of any portion of its road, whether heretofore made or hereafter to be made, but shall not depart from the general route prescribed in the articles of incorporation.

Section 3278. For the purpose of making any such change, the company shall have all the rights, powers and privileges to enter upon and appropriate lands, and make surveys necessary to effect such change, upon the same terms, and subject to the same obligations, rules and regulations as are prescribed by law, except that, when it is necessary to appropriate property for any such change, the appropriation may be had, if the probate court, in the proceedings instituted therefor, find that the proposed change will conduce to the interests of the company and the public, and that the property and rights of those owning real estate along the portion of the road to be affected by the change will not be unreasonably injured thereby; but when the location is changed after the road has been used for transportation of persons and property, the company shall be liable for all damages occasioned by such change to the owner of the land upon which the road was first constructed.

Section 3323. Each company shall erect, at all points where its road crosses a public road, at a sufficient elevation from such public road to admit of the free passage of vehicles of every kind, a sign, with large and distinct letters placed thereon, to give notice of the proximity of the railroad, and warn persons to be on the lookout for the locomotive; and a company which neglects or refuses to comply with this provision shall be liable in damages for all injuries which occur to persons or property from such neglect or refusal.

Section 3324. A company or person having control or management of a railroad shall construct, or cause to be constructed, and maintain in good repair on each side of such road, along the line of the lands of the company owning or operating the same, a fence sufficient to turn stock; and when such fence is constructed out of barbed wire, or separate lateral strands not connected by interwoven wire, or cross perpendicular wire not more than 15 inches apart, there shall be securely fastened to the posts, at the top of the same, at right angles thereto, at least one board, not less than 1⅛ inches thick and 5 inches wide, and extending the entire length thereof; and before operating such road shall cause to be maintained at every point where any public road, street, lane or highway used by the public, crosses such railroad, safe and sufficient crossings, and on each side of such crossings cattle-guards sufficient to prevent domestic animals from going upon such railroad; and such company or person shall be liable for all damages sustained in person or property in any manner by reason of the want or insufficiency of any such fence, crossing or cattle-guard, or any neglect or careless ness in the construction thereof, or in keeping the same in repair. That, provided, where any road now in process of construction, or any proposed road, passes through any inclosed land, that the company or person having control of any such road shall, during the construction of the same, provide suitable crossings for the owner or occupant of each farm, and make and keep in repair fences along the line of such road through such inclosed fields, and protect any crops growing thereon; and

further provided, that where the company or person agrees, with the owner of the lands through which any railroad passes, that said owner shall build and keep in repair any portion of the fencing, and should said fencing be destroyed or damaged by fire from passing trains, said company or person owning or operating such road shall rebuild or repair said fence, provided the property holder should demand it; and provided, that if any railroad company shall fail or refuse to construct any fence in the manner hereinbefore provided, within 6 months after the passage of this Act, and after having received written notice so to do from the owner or occupant of any lands through which the road may pass, (that) then said owner or occupant may, after 30 days from the time of serving such notice upon the agent of such company nearest said lands, proceed to construct the same, and the company shall be liable to such person for the cost thereof. This Act shall apply to all fences now built, as well as those hereafter constructed.

Section 3327. A person owning 15 or more acres of land in one body through which any such railroad passes, and which is so situate that he cannot use a crossing in a street, road, lane or highway, in passing from his land on one side of the railroad to that on the other side without great inconvenience, the company or person operating the road shall, at the request of the landowner, within four months after such request, at the expense of such company or person, construct a good and sufficient crossing across the railroad and the lands occupied by the company, between the two pieces of land of the landowner, to enable him to pass with a loaded team, and over which he shall have the privilege of passing at all times when such company or person is not using the railroad at the crossing, or so near thereto as to render crossing thereat dangerous.

Section 3336. Every company shall have attached to each locomotive engine passing upon its road, a bell of the ordinary size in use on such engine, and a steam whistle; and the engineer or person in charge of an engine in motion and approaching a turnpike, highway, toward [town road] crossing or private crossing, where the view of said private crossing is obstructed by embankment, trees, curve or any other obstruction to view, upon the same line therewith, and in like manner where the road crosses any other traveled place, by bridge or otherwise, shall sound such whistle at a distance of at least 80 and not further than 100 rods from the place of such crossing, and ring such bell continuously until the engine passes such crossing; but the provisions of this section shall not interfere with the proper observance of any ordinance passed by any city or village council regulating the management of railroads, locomotives and steam whistles thereon, within the limits of such city or village.

Section 3337—1. That it shall be unlawful for any person, company or corporation, owning, or operating any railroad, crossing, or that may hereafter cross, over and above any street, less than 70 feet in width, in any city in this state, at an elevation above such street sufficient to permit persons to pass and repass along such street beneath such railroad crossing, to place or cause to be placed, or to suffer or permit to be or remain in such street, beneath such railroad crossing or bridge, any pier or other stay or support for such crossing or bridge, or to suffer or permit any such railroad crossing or bridge to be or remain in such condition that any iron, coal or other hard substance, or any fluid or noisome matter may fall or drop from or through any such crossing or bridge upon persons traveling or passing beneath the same; and any such person, company or corporation owning or operating any such railroad, failing to comply with the requirements of, or violating any of the provisions of this section, shall, for each and every day during the con-

tinuance of such failure or violation, and on account thereof, forfeit and pay to such city the sum of $100, which may be recovered in a civil action, in the name of such city, against the owner or operator of such railroad, or both, as the city may elect, and thereafter like recovery may be had in like manner for subsequent failures and violations aforesaid.

Section 3337.—3. That all railway or railroad companies operating a line or lines of railway in this state shall build or cause to be built, and keep in repair, good and sufficient crossings over, or approaches to such line or lines of railway, its tracks, sidetracks and switches, at all points where any public highway, street, lane, avenue, alley, road or pike is now or may hereafter be intersected by such lines of railway, its tracks, sidetracks or switches. And also good and sufficient sidewalks on both sides of streets intersected by their roads, the full width of the right-of-way owned, claimed or occupied by them; and as to crossings and approaches outside of municipal corporations, the township trustees shall have power to fix and determine the kind and extent thereof, and the time and manner of constructing the same; and as to crossings, approaches and sidewalks within municipal corporations, the municipal councils shall have and exercise the same powers as trustees concerning crossways and approaches outside of municipalities, and such crossways, approaches and sidewalks shall be constructed, repaired and maintained by the railroad companies as so ordered.

Section 3337—4. It shall be the duty of the officer or officers having charge of any public highway, street or alley intersected by any line of railway to serve a written notice upon the nearest station agent or section foreman having charge of that portion of the railway where such intersection occurs, that such crossing, approach or sidewalk as herein described shall be built or repaired, setting forth the kind and extent thereof, and time and manner of constructing the same, as ordered by the council or trustees.

Section 3337—5. It shall be the duty of any railway company so notified to comply with said notice within a period of thirty (30) days from and after receiving such notice, and on failure so to do, the township trustees, or council, as the case may be, may cause such crossing, approach or sidewalk to be constructed or repaired as before ordered, and may recover the cost of so doing, with interest thereon, in a civil action against the railroad company, in the name of the trustees or municipality, as the case may be, before any court of competent jurisdiction.

Section 3337—6. It shall be the duty of all railway companies owning or operating any line of railway within the limits of the state of Ohio to, at all times, keep all public highways, now or hereafter crossing such line of railroad, clear of snow, so that the same shall at all times be in a safe and convenient condition for travel, for a distance of fifty (50) feet each way from the center of said railroad along such highway.

Section 3337—7. Any railroad company which shall neglect to comply with the terms of this act shall be liable to pay damage to the city, village, town or township in which the highway is situated in the sum of thirty ($30) dollars for such neglect, and a further sum of ten ($10) dollars per day for each and every day such railroad company fails or neglects to comply with the terms of this act, the same to be recovered in an action brought in the name of the city, village, town or township, as the case may be. It is hereby made the duty of the prosecuting attorney of the county to prosecute to judgment any claim arising under the foregoing provisions, without any charge to the said city, village, town or township.

Section 3337—8. That if the council or board of legislation of any municipal corporation in which any railroad or railroads, and a street or other public highway cross each other at grade [or] otherwise, or the commissioners of any county in which, outside of any municipal corporation, a railroad or railroads and any public road or highway cross each other at grade, and the directors of the railroad company or companies are of the opinion that the security and convenience of the public require that alterations shall be made in such crossing, or in the approaches thereto, or in the location of the railroad or railroads or the public way, or any grades thereof, so as to avoid a crossing at grade, or that such crossing should be discontinued with or without building a new way in substitution therefor, and if they agree as to the alterations which should be made, such alterations may be made in the following manner:

Section 3337—9. When it is deemed necessary by any municipality, or by any county, to join with any railroad company or companies in the alteration or abolition of any grade or other crossing, the council or board of legislation of the municipality, by a two-thirds vote of all the members elected thereto, or the commissioners of the county, by a unanimous vote of all the members thereof, shall, by resolution, declare such necessity and intent, and shall state in such resolution the manner in which the alteration in the crossing are to be made, giving the method of constructing the new crossing, with the grades for the railroad or railroads and the public way or ways; also what land or other property it is necessary to appropriate, and how the cost thereof shall be apportioned between the municipality or county and the railroad company or companies; also by whom the work of construction is to be done and how the cost thereof shall be apportioned between the municipality or county and the railroad company or companies. Such resolution shall be published and notice of its passage given to owners of property abutting on the proposed improvement in the manner provided in section 2394 of the revised statutes, and all claims for damages by reason of such improvement must be filed in the manner and within the time provided by section 2315 of the revised statutes.

Section 3337—10. In not less than 30, nor more than 90, days after the passage of the resolution provided for in section 2 hereof, the council, board of legislation or commissioners shall determine whether it or they will proceed with the proposed improvement or not; if it is decided to proceed therewith, an ordinance by the council or resolution by the commissioners shall be passed, which ordinance or resolution shall contain, in addition to the terms and conditions stated in the resolution under section 2 hereof, the plans and specifications of the proposed alteration and improvement, also a statement of the damages claimed or likely to accrue by reason thereof, and how the payment thereof shall be apportioned between the municipality or county and the railroad company or companies; also, who shall supervise the work of construction. Upon the acceptance of this resolution or ordinance by resolution by the railroad company or companies through the directors thereof, the same shall constitute an agreement, which shall be valid and binding on the municipality or county and the railroad company or companies, respectively; provided, however, that such agreement shall be thereupon filed in the Court of Common Pleas of the county in which the crossing is located, for entry upon the records thereof; whereupon it shall have the same force and effect as a decree of the court.

Section 3337—11. The land or property required to make the alteration in the street or highway necessitated by the proposed improvement shall be purchased or appropriated by the municipality or county after the manner provided by law for the appropriation of private prop-

erty for public use, and the land or property required to make the alteration in the railroad or railroads, necessitated by the proposed improvement, shall be purchased or appropriated by the railroad company or companies after the manner provided for the appropriation of private property by such corporation.

Section 3337.—12. The cost of the construction of the improvement in the crossing, including the cost of land or property purchased or appropriated, and the payment of damages to abutting property shall be apportioned as follows: The railroad company or companies (if several railroads cross a public way at or near the same point) shall pay not less than 65 per centum of such cost, and the municipality or county shall pay not more than 35 per centum of such cost. Within these limits the apportionment may be fixed by the agreement under section 3 hereof.

Section 3337—13. After the completion of the work the crossing and its approaches shall be kept in repair as follows: When the public way crosses the railroad by an overhead bridge, the framework of the bridge and its abutments shall be maintained and kept in repair by the railroad company, and the surface of the bridge and its approaches shall be maintained and kept in repair by the municipality or county in which the same are situated. When the public way passes under the railroad the bridge and its abutments shall be maintained and kept in repair by the railroad company, and the public way and its approaches shall be maintained and kept in repair by the municipality or county in which they are situated.

Section 3337—14. For the purpose of raising the money to pay the proportion of the cost of such improvement payable by the municipality or the county, the bonds of the municipality or the county may be issued to the necessary amount, which bonds shall be of such denomination and payable at such place and times as the council or board of legislation, or the commissioners may determine, and shall bear interest not exceeding 5 per cent. per annum, and shall not be sold for less than their par value. A tax on the taxable property of the municipality or county, not exceeding one-half mill in each year, may be levied to pay the principal and interest of the bonds as the same may mature. After the completion of the improvement, a tax may be levied by the municipality or county to pay the cost of maintaining and keeping in repair that part of the work required to be maintained and kept in repair by it.

Section 3337—15. All claims for damages, by reason of such improvement, filed in accordance with the provisions of section 2 hereof, shall be assessed and determined in accordance with the provisions of sections 2316 to 2326, inclusive, of the revised statutes, and either before commencing or after the completion of the proposed improvement, as the council or board of legislation or commissioners may decide at the time it is determined to proceed with the proposed improvement.

Section 3337—16. In case the railroad company fails to comply with any provisions of any agreement entered of record in a court of common pleas, under this Act, such court, upon the application of a city solicitor or prosecuting attorney, stating the nature of such non-compliance, may make such orders and decrees as it may deem proper and just to enforce the terms of the agreement and the requirements of this Act on the part of the railroad company, and to secure its compliance therewith, and for such purpose may, if it deem the same necessary, restrain and enjoin the railroad company from the use of its track and the operation of its railroad on and over the crossing in question, until it shall have complied with the order and decree of the court; provided, that nothing in this Act shall be construed to exempt railroad companies from any obligations or liabilities under existing statutes.

Section 3337—17. When any grade crossing is on a county line road, the commissioners of each county in which such crossing is situated may join in all the proceedings necessary for the abolition of such grade crossing as provided in this Act, and that part of the cost of making such change in the crossing and of keeping the same in repair which is not agreed to be paid by the railroad company or companies, shall be paid by the counties in equal proportions, and the money for such purpose shall be raised in accordance with section 7 of this Act.

Section 3337—18. That all bridges, viaducts, overhead roadways or foot-bridges, wire and other structure hereafter constructed over the track or tracks of any railroad or railroads within the state of Ohio, by any county, municipality, township, railroad company, or other private corporation or person, shall be of such height as to be not less than 21 feet in clear from the top surface of the rails of said track or tracks to said wire and other structure, or to the bottom of the lowest sill, girder or cross-beam, and the lowest downward projection on such bridge, viaduct, overhead roadway or foot-bridge, except in cases where the commissioner of railroads and telegraphs shall find such construction is impracticable, and in every such case said commissioner shall file a written statement in his office setting forth the facts relied upon by him in making such finding; but this provision shall not apply to any main track; provided, that where any bridge, viaduct, overhead roadway or foot-bridge over a railroad track or tracks is rebuilt, it shall be brought under the provisions of this Act, and in such case, if said structure is at, or in line of, a public street or highway, and is thus erected above the grade of any such street or highway, thereby making it necessary to raise the grade of such street or highway and any cross-street or streets, the cost of making such street or streets or highway or highways conform to such new grade, and all damages to owners of property abutting on such street or streets, highway or highways, because of such change of grade, shall be ascertained and determined and paid as follows: Said or any railroad company or its assigns shall pay all costs and damages resulting, as aforesaid, from the raising or building of any of its bridges or structures, as aforesaid, in the line of any street or highway at a greater height than before the passage [of] hereof; and if any such company is only part owner of any such structure, it shall pay its proportionate share of the cost of such change of grade and damages. Should a railroad company, or its assigns, raise the grade of its track or tracks, under any of said structures not owned by it after the passage of this Act, thereby causing any said bridge or structure to be put at a higher grade when rebuilt, said company shall pay all costs and damages as aforesaid made necessary thereby.

Section 3337—19. It is hereby made the duty of the commissioner of railroads [and] telegraphs to see that the provisions of this Act are carried into effect; and every railroad company in the state of Ohio, public or private corporation, or person, building, or permitting to be built, any bridge, viaduct, overhead roadway or foot-bridge, or wire and other structure, as specified in section 1 of this Act, shall file with the said commissioner plans and specifications, and first receive from him a permit before being allowed to proceed with said structure, and the erection of said wire. Any person, corporation, public or private, violating the provisions of this act, upon conviction before a court of competent jurisdiction, shall be fined any sum not less than $100 nor more than $1,000; and every day that said structure or wire, not in conformity to the provisions of this act, is permitted to remain, shall constitute a separate offense. The observance of the provisions of this act may be enforced by injunction on complaint of any person, corporation or board interested therein.

Section 3337—20. That hereafter all telegraph, telephone, electric light or other wires of any kind constructed over the line of any steam railroad within the state of Ohio shall be put up on good substantial poles of a size not less than 12 inches in diameter at the bottom, and not less than 6 inches in diameter at the top, and that they be set in the earth not less than one-sixth of their length and well tamped. Double cross-arms shall be used in all cases and all wires shall be insulated with glass or porcelain insulators and securely fastened to both cross-arms. All wires to clear the top of the rails at least 25 feet, except in cases of trolley wire crossings, when such height as may be agreed upon is approved by the commissioner of railroads shall govern. Where there is side-strain, poles shall be well guyed or braced.

OKLAHOMA.

Railroads may build and operate over and cross highways, turnpikes, or plank roads, or any other way, or may raise or lower any such roads for the purpose of having its road pass over or under the same, and in such case such railroad shall put such road so crossed as soon as may be in good repair. While making any alteration in a highway for the purpose of passing over, under or across same at grade, such railroad shall provide a suitable temporary way to enable the passage to and fro across such obstruction, and must keep same in repair. Also provides that railroads must keep in good repair all bridges, with their abutments, which may be constructed for the purpose of enabling its railroad to pass over or under any turnpike, road, canal, watercourse, or highway.

Signboards are required to be maintained at public crossings containing the warning, "Railroad Crossing—Look Out for the Cars." These letters must be painted in black, on white ground, at least eight inches in length, and proportionately broad. Signs must be placed on posts at least 14 feet high. In case of the refusal or neglect of railroads to place signboards, they may be erected at the expense of the railroad company by the county commissioners.

The usual provisions for a bell of 30 pounds' weight and a steam whistle are enacted, to be sounded at a distance of at least 80 rods from the place where the railroad crosses a highway or street.

OREGON.

No legislation in regard to highway grade crossings has been enacted in this State.

PENNSYLVANIA.

Railroad companies in the construction of their roads can cross or intersect with any public road, street, or alley at grade, and if necessary change the site of any portion of any turnpike, public road, or street, but in such case it must reconstruct the same forthwith at its own expense, in the most favorable location, and in as perfect a manner as the original road, but it is not obliged to construct a new road before changing the site of the old one.

As to crossings, in the absence of any statutory provision on the subject, the company can construct such crossing—either grade, overhead or under—as in the exercise of sound discretion it deems proper or suitable to the location; it may change the site of a public road to avoid a grade crossing, but its right to change an overhead to a grade crossing is denied,

and if in changing the bed of a public road, the construction of a bridge is necessary, the company must not only construct, keep in repair, but reconstruct said bridge when necessary.

Signboards are not required by statute at crossings, but using that caution commensurate with danger, all railroads have signboards at grade crossings.

There is no statute requiring the sounding of bell or whistle at public crossings, but under the decisions of the Supreme Court it is the duty of those in charge of a railroad train approaching a public crossing to give notice thereof by whistling, ringing the bell or by some other device, and in sufficient time to warn and enable travelers approaching the crossing to stop, or those on the track to get out of danger, and if proper notice is given the train is not bound to slow up or stop as it approaches a grade crossing in the country.

It is neither a statutory or a common law duty of a railroad company in this state to station flagmen or maintain gates at a public grade crossing, but the authorities in cities under their corporate authority or powers can require railroad companies to place flagmen and maintain gates at grade crossings within the city limits as a police regulation.

Railroad companies are not under statutory obligation to fence the line of their roads or construct cattle-guards, but it has been held in several cases that if a railroad company fails to erect cattle-guards or put up fences at a point where cattle are in the habit of straying, it is guilty of negligence. However, since the act of 1889, which requires all owners to fence against their stock, not that of their neighbors, these cases are regarded as obsolete.

By special acts passed some years ago, railroad companies operating in the counties of Erie, Warren, Venango, Bradford and McKean, were required to fence the line of their roads, and construct and maintain cattle-guards to prevent disorderly cattle from trespassing on their tracks, but it is believed that the repeal of the general fence law renders said special laws nugatory in counties where the repeal is effective, if indeed, not in all.

RHODE ISLAND.

Section 11. Every railroad corporation shall cause a bell of at least 32 pounds in weight to be placed on each locomotive engine passing upon its road, and said bell shall be rung at a distance of at least 80 rods from the place where such railroad crosses any turnpike, highway or public way upon the same grade with the railroad, and shall be kept ringing until the engine has crossed such turnpike or road. No car or carriage for the transportation of passengers or freight over any railroad in this state shall be propelled across any highway, after the locomotive has been detached therefrom, unless a bell be rung or a whistle be sounded at said crossing during the whole time the train is crossing such highway.

Section 12. Every railroad corporation shall cause to be erected and to be maintained at every turnpike, highway or public way, where it is crossed by the railroad upon the same level therewith, a suitable signboard upon each side of the crossing; and on each side of said signboards shall be painted in black capital letters of at least the length of nine inches these words: Railroad Crossing, Stop, Look and Listen. Said signboards shall be erected and placed under the direction and with the consent of the railroad commissioner. Every railroad corporation shall also adopt such other precautionary measures at such grade crossings as shall be deemed proper by the railroad commissioner.

Section 18. Every corporation which maintains or uses railroad

tracks in any street or highway in any town or city in this state shall be liable to keep and maintain in good order and repair, including paving and repaving whenever and wherever necessary, that portion of any street or highway occupied by its railroad and 18 inches outside of any of its rails, in order that such streets and highways may be safe and convenient for travelers with their teams, carts and carriages at all times, and the extent of such liability shall not be varied; provided, however, that the character of such paving, repaving and repairing, shall be such as is from time to time fixed by the town or city councils of the respective towns and cities; and provided further, that nothing herein contained shall relieve any railroad corporation from the payment of any sum of money which it is now required by law to pay to any town or city for the use and occupancy of the streets and highways in such town or city.

Section 24. No bridge shall hereafter be built over any railroad track, unless it shall measure at least 18 feet in the clear, measuring from the bottom of the lowest timber to the top of the rail on said track, excepting bridges erected in renewal or in place of bridges now existing.

Section 44. If the town council of any town wherein a turnpike or highway crossed by a railroad on a level therewith is situated, are of the opinion that it is necessary for the security of the public that the turnpike or highway should be raised or lowered, so as to pass over or under the railroads, they may in writing request the corporation owning the railroad so to raise or lower such turnpike or highway. If the corporation shall neglect or refuse so to do, the town council may apply to the railroad commissioner to decide upon the reasonableness of the request. If the railroad commissioner, after due notice and hearing the parties, shall decide that such lowering or raising of grade is necessary for the security of the public, the corporation shall comply with the decision; provided, that either party shall have the right, within 30 days after such decision, to petition the appellate division of the Supreme Court for relief, in substantially the same form, and with like procedure, as is prescribed in section 3 of chapter 184; and said court shall have full power to finally decide said question as to the necessity of changing said grade. The cost and expense of making said change of grade shall be borne by the railroad corporation and the town asking for such change, in such proportion as may be decided by said court. If after decision of said court that a change of grade is necessary, or if, having taken no appeal from the decision of the railroad commissioner as aforesaid, the corporation shall unreasonably neglect or refuse to change the said grade, the town council may proceed to make said change, and may in an action against the corporation recover all charges and expenses occasioned by making the alterations.

Section 45. No railroad corporation shall lay out or build its road or lay its tracks across any railroad, street, highway, turnpike or traveled way at grade, and no street, highway, turnpike or road shall be laid out or built across any railroad track at grade, except by the consent of the railroad commissioner thereto, expressed in writing; provided, that if said railroad commissioner shall refuse to consent to any such crossing at grade, said corporation, or any party aggrieved by such refusal, may petition the appellate division of the Supreme Court for relief, and the decision of said court shall be final. Said petition shall be preceded by citation to said railroad commissioner in substantially the same form, and the like procedure shall be had, as is prescribed in section 3 of chapter 184.

Section 47. Every railroad corporation, or trustees of such corporation, operating railroads within the state, shall cause flagmen to be placed wherever railroads cross public highways, whenever in the opinion of the town council it is necessary for the safety of the public.

Section 49. Every railroad corporation whose roadbed crosses the public highway at grade shall cause such crossing to be covered with suitable material for highway travel so that the surface of said highway at said crossing shall not at any time be lower than three-fourths of one inch below the tops of the rails at said crossing; and every railroad corporation which shall neglect or refuse to comply with the provisions of this section, after being notified by the town council of the town wherein such crossing is located, shall be fined not exceeding $100.

Section 50. Every railroad corporation operating a railroad or part of a railroad in this state shall adjust, fill or block the frogs, switches and guard-rails on its tracks, with the exception of guard-rails on bridges, so as to prevent the feet of its employes from being caught therein. The work shall be done to the satisfaction of the railroad commissioner, evidenced by his certificate. Any railroad corporation failing to comply with the provisions of this section shall be fined not less than $100 nor more than $1,000.

Section 51. No railroad corporation, nor its servants or agents, shall willfully or negligently obstruct or unnecessarily use or occupy a highway, townway or street, nor in any case at a street or highway grade crossing, with cars or engines for more than five minutes at one time; and whenever a highway, townway or street has been thus used or occupied with cars or engines, no railroad corporation shall again use or occupy the same with cars or engines until a sufficient time, not less than three minutes, has been allowed for the passage across the said railroad of such travelers as were ready and waiting to cross when the former occupation ceased. For every violation of the provisions of this section the corporation shall be fined not less than $25 nor more than $100.

Section 52. At any point where a highway, townway or traveled place is crossed at the same level by a railroad where a gate or flagman is not maintained, the railroad commissioner may, after notice to and hearing of the railroad corporation whose road so crosses, direct in writing that such crossing shall be furnished with such electric signal or signals as he shall decide the better security of human life or the convenience of the public travel requires, and the corporation shall comply with such order. If said railroad corporation shall refuse or neglect to comply with said order within three months from the date thereof, it shall be fined $25 for each day that said refusal or neglect shall continue, unless it shall furnish reasons satisfactory to said railroad commissioner for said refusal or neglect. Nothing in this section shall be so construed as to affect sections 47 or 48 of this chapter.

SOUTH CAROLINA.

When a railroad is laid out across a highway or other way, it shall be so constructed so as not to obstruct the same.

A railroad corporation may raise or lower any highway or other way for the purpose of having its road pass under or over the same; but before proceeding to cross, alter or excavate for the purpose of crossing the way it shall obtain from the board of county commissioners a decree prescribing what alterations may be made in the way, the manner and time of making the alterations or structures the commissioners may require at the crossing; and before entering upon, excavating, or altering the way, shall give security satisfactory to the commissioners that it will faithfully comply with the requirements of the decree to the acceptance of the commissioners, and indemnify the city or town from all damages and charges by reason of any failure to do so.

Railroad corporations may alter the course of a highway or other way,

other than a street in an incorporated city, town or village, for the purpose of facilitating the crossings of the same by its road, or permitting its road to pass at the side thereof without crossing, upon obtaining a decree of the board of county commissioners prescribing the manner and time of such alteration. The corporation shall pay all damages occasioned to private property by the alteration, as in the case of land taken for its road.

Railroad companies whose tracks cross a highway or other way on a level therewith are required to provide suitable crossings so as to secure a safe and easy passage across its road; and if deemed necessary by the board of county commissioners, or if such highway be within a city, town or village, by the municipal authorities, additional safeguards may be required at the crossing, they may order the corporation to establish the same.

Signboards are required to be erected and constantly maintained alongside of each public road or street crossed by a railroad on the same level, the signs to be elevated so as to be easily seen by travelers, and on each side of the same shall be painted in large letters the words, "Railroad Crossing."

Railroad companies are required to construct and keep in repair an adequate stock-guard or cattle-gap at every point where the line of said railroad crosses the line of any fence in this state.

A bell of at least thirty pounds' weight and a steam whistle shall be placed on each locomotive engine, and the bell shall be rung or the whistle sounded by the engineer or fireman at least five hundred yards from the place where the railroad crosses any public highway or street or traveled place, and kept ringing or whistling until the engine has crossed such highway or street or traveled place.

SOUTH DAKOTA.

Section 3014. Singboard at Crossings.—Every railroad corporation operating a line of road within this territory must erect suitable signs of caution at each crossing of its road with a public highway, which signs shall be painted with black, Roman or block letters, on white background, "Railroad Crossing, Look Out for the Cars;" said letters to be at least eight inches in length, and proportionately broad; said signs shall be placed at the top of posts at least fifteen feet high.

Section 3015.—In case any railroad corporation shall refuse or neglect, for a space of thirty days after notice given by the board of county commissioners, to comply with the provisions of the preceding section, it shall become the duty of the county commissioners of each county through which any such railroad shall be in operation to erect such signs, and the company shall be liable for all expenses so incurred by said commissioners.

Section 3016. Bells and Whistles.—A bell at least thirty pounds' weight, or a steam whistle, shall be placed on each locomotive engine, and shall be rung or whistled at the distance of at least 80 rods from the place where the said railroad shall cross any other road or street, and be kept ringing or whistling until it shall have crossed said road or street, under a penalty of fifty dollars for every neglect, to be paid by the corporation owning the railroad, one-half thereof to go to the informer, and the other half to this state, and also be liable for all damages which shall be sustained by any person by reason of such neglect.

Cattle-Guards.—The law of South Dakota does not require railway companies to fence their tracks and put in cattle-guards. Section 3018 provides that "Whenever the owner of any tract of land abutting against any line of railroad within the state shall desire to enclose any such tract of land for pasturage or other purposes, and shall construct a good and

sufficient fence about said tract of land on all sides, except along the side abutting against such railroad, it shall be the duty of such railroad company to construct a good and sufficient fence not less than four and one-half feet high, on the side of such tract or lot so far as the same extends along the line of such railroad, and to maintain the same in good repair and condition until released therefrom by the owner of said tract, or until the owner of said tract shall have ceased to maintain in good repair and condition, for the term of one year, his portion of the fence around such inclosure."

This is the only case where the company is obliged to build a fence and there is no provision for a cattle-guard.

Section 2989. The Crossing of Highways, Over, Under, or at Grade. —"When it shall be necessary in the construction of a railroad to erect a bridge or culvert over any highway, street, turnpike or plank road, toll or wagon road, it shall be sufficient to construct the same so as to give a clear passageway of twenty feet, or two passageways of fourteen feet each."

Section 3013.—Every railroad corporation shall maintain and keep in good repair all bridges, with their abutments, which such corporation shall construct for the purpose of enabling its road to pass over or under any turnpike road, canal, watercourse, or other way.

Section 3017.—When any person owns land on both sides of any railroad, the corporation owning such railroad shall, when required so to do, make and keep in good repair one causeway or other safe and adequate means of crossing the same.

In Cities.—Under the general Act for the incorporation of cities, city councils are given the power: "To provide for and change the location, grade and crossing of any railroad."

"To require railroad companies to fence their respective railroads, or any portion of the same, and construct cattle-guards, crossings of streets and public roads, and viaduct or overhead crossings, and keep the same in repair within the limits of the city."

Flagmen.—"To require railroad companies to keep flagmen at railroad crossings of streets, and to provide protection against injury to persons and property; to compel such railroad to raise or lower their railroad tracks, to conform to any grade which may at any time be established by such city, and where such tracks run lengthwise of any such streets, alley or highway, to keep their railroad tracks on a level with the street surface, and so that such tracks may be crossed at any place in such street, alley or highways; to compel and require railroad companies to make and keep open and keep in repair, ditches, drains, sewers, and culverts along and under their railroad tracks, so that filthy or stagnant pools of water cannot stand on their grounds or right-of-way, and so that the natural or artificial drainage of adjacent property shall not be impaired."

All the above matters in cities are regulated by ordinance, such as the various city councils may from time to time pass.

The Lighting of City Crossings.—City councils have general power "To provide for lighting the streets."

There is no statute defining the duties of a railroad company in regard to lighting city crossings. The various city councils may take whatever action is authorized in the above grant of power.

TENNESSEE.

Section 1574. Signboards at Crossings.—The overseers of every public road crossed by a railroad shall place at each crossing a sign, marked "LOOK OUT FOR THE CARS WHEN YOU HEAR THE

WHISTLE OR BELL;" and the county court shall appropriate money to defray the expenses of said signs; and no engine driver shall be compelled to blow the whistle or ring the bell at any crossing, unless it is so designated.

The above section is applicable to all railroads chartered prior to 1875, but since 1875 the charters of all railroads contain a provision to the following effect:

2418. Boards, well supported by posts or otherwise, shall be placed and constantly kept across each public road when the same is crossed on the same level by the track of the railway, the boards to be elevated so as not to obstruct travel; and on each side of said board there shall be printed in large letters, easily to be seen by the traveler, the words, "RAILROAD CROSSING—LOOK OUT FOR THE CARS."

2419. Boards need not be put up at the crossing of streets and alleys in cities, towns, and villages, but such railroad company shall be subject to such proper regulations made by municipal authorities in pursuance of general municipal powers regulating speed, passage, and flagmen, in such municipalities and at crossings; and where there are sidings and switches, the whistle shall always be blown at a distance of not less than 250 yards from every crossing of a public road. When land on both sides of the track is owned by the same proprietor, convenient crossing shall be made and kept up, at the expense of the corporation, for the use of said proprietor, and all necessary cow gaps made.

As to Cattle-guards at Crossings.—There is no statute in this state requiring railroads to put cattle-guards at each side where they cross public or private ways. There is, however, a statute making railroad companies liable for any stock killed or crippled by any train of cars or locomotive upon any unfenced railway within this state. This law is found in section 1587 of Shannon's Code, and is as follows:

1587. Any person, company, or corporation, or lessee or agent thereof, owning or operating any railroad within the State of Tennessee, shall be liable for the value of any horse, cow or other stock killed, and reasonable damage for any injury to any such live stock upon or near the track of any railroad in this state, whenever such killing or injury is caused by any moving train, or engine or cars upon such track; provided, contributory negligence on the part of the plaintiff in any action or suit to recover damages for such killing or injury may be set up as a defense; but provided further, the allowing of stock to run at large upon common, unfenced range, or upon inclosed land owned or in possession of the owner of such stock shall not be deemed or held to be such contributory negligence; provided further, in any such suit or action, proof of willful intent on the part of the plaintiff therein to procure the killing or injury of any such stock, in the manner aforesaid, shall defeat the recovery of any damages for such killing or injury.

The effect of this law is to make railroad companies absolutely liable for the killing of all stock on unfenced track, and therefore to protect themselves against such liability it is necessary for them to provide cattle-guards and wing fences at all points where public roads cross the railroad track, so that stock cannot go from the public road on to the right-of-way of the railroad companies.

The same is also true as to all private ways leading to cemeteries, schoolhouses, or churches. This results from the following section of Shannon's Code:

6514. It shall be a misdemeanor for any person to obstruct the

public highways, private ways, streets, alleys, sidewalks, public grounds, cemeteries, and ways to burying places, churches, or schoolhouses, and it shall be an obstruction for any person to ride horseback, drive horses upon, or drive a wagon, buggy, or any vehicle upon said sidewalks.

As to all farm crossings where the railroad has been incorporated since 1875, refer to Shannon's Code, section 1418, above set out. As to railroads chartered prior to 1875, the provisions of their respective charters govern.

Section 1974. As to the Sounding of Bell or Whistle at Crossings.—On approaching every crossing or designated spot section 1974 (1) above set out, the whistle or bell of the locomotive shall be sounded at the distance of one-fourth of a mile from the crossing, and at short intervals, till the train has passed the crossing.

The provisions as to crossing over, under or at grade at highways, the charters of all railroads incorporated since 1875 contain the following provision:

The line or track of the road shall be so constructed as not to interfere with the convenient travel of the public along the highways, county roads, streets and alleys of cities, towns, and villages, and so as to allow carts, wagons, carriages, and other vehicles conveniently and safely to pass over or under the line or track, and so as not to interrupt travelling on foot or horseback, or in vehicles of any kind from the necessary and proper use of the public road, street or alley, in the usual and proper mode for their convenience.

There is also a general Act passed by the legislature of 1880, which provides as follows: [page 84]

Every railroad company, or corporation, or person operating a line of railroad within the State of Tennessee, shall be required to grade to a level with the rails of said railroad and to keep in repair every public road crossing such railroad for a distance of 20 feet on each side of such railroad track and between the rails thereof, provided that the provisions of this Act shall not apply within the limits of any city, taxing district, or incorporated town.

There are no general statutes with reference to overhead bridges.

Flagmen or City Streets.—There is no general statute on this subject. It is regulated entirely by municipal ordinances. See Shannon's Code, section [illegible], where set out.

TEXAS.

Where two railroad lines cross each other at grade, trains are required to come to a full stop. Where an interlocking switch and signal apparatus has been erected, or a flagman is in accordance as such crossings the full stop is not required.

Signs must be erected to warn the public, and a bell on the locomotive must be rung at a distance of at least 80 rods from the place where a railroad crosses a highway or street.

UTAH.

436. Surveys—Eminent Domain—Crossings—Branch Lines—Rules.—Any company incorporated under the provisions of this chapter or constructing or operating a railway in this state in addition to other rights conferred, shall have power to enter, by its servants, upon the real property of any person, for the purpose of selecting or ad-

vantageous route for its main line or any branch thereof, or for the purpose of relocating its line, subject to responsibility for all damages resulting therefrom; to acquire by purchase, donation, or otherwise, all such real and personal property as may be necessary for, or may be given to aid or encourage the construction and maintenance of its railroad and for its buildings and yards; to condemn, in the manner provided by law, a right-of-way, not to exceed 9 rods in width, with such additional lands as may be necessary for depot grounds or for the purpose of constructing necessary embankments, excavations, ditches, drains, culverts, or for the procuring of timber, stone, gravel, or other essential materials; to cross natural or artificial streams or bodies of water, streets, highways, or railroads which its road may intersect, in such manner as to afford security for life and property and subject to the duty of immediately restoring such course or body of water, street, highway or railway to its former condition, as nearly as may be; to cross, intersect, join, or unite its railroad with any other railroad, either before or after construction, at any point upon its route, and upon the grounds of such other railroad corporation, with the necessary turnouts, sidings, and switches, and other conveniences in furtherance of the objects of its connections, and every corporation whose railroad is or shall be hereafter intersected by any new railroad, shall unite with the owners of such new railroad in forming such intersections and connections, and grant facilities therefor; to construct and operate spurs or branch lines of railroad connecting with the main line or any branch thereof, not to exceed 5 miles in length each, though such spurs or branch lines be not named or described in the articles of incorporation, and to relocate any section or sections of its lines between the principal termini, with the same powers as in the case of original or first locations; to take and transport persons and property by steam, electrical, mechanical, or animal power, or by any combination thereof, and receive such compensation therefor as may be conformable to law; and to make such regulations regarding the movement of its trains or cars and the manner of transporting passengers and freight and for the management of its property, as may be reasonable and conformable to law.

437. Street and Highway Crossings.—No railroad shall use any road, street, alley, or highway within any county, city, or town, except with the consent of the authorities of such county, city, or town, as provided by law; provided, that this section shall not be construed to prevent railroads from crossing at right angles, or as nearly as may be, any street, alley, or highway across which its located line may pass.

440. Railways and Highways Through Canyons.—Any railroad company whose right-of-way, or whose track or roadbed upon such right-of-way, passes through any canyon, pass, or defile, shall not prevent any other railroad company from the use and occupancy of the said canyon, pass, or defile, for the purposes of its road, in common with the road first located, or the crossing of other railroads at grade; and the location of such right-of-way through any canyon, pass, or defile shall not cause the disuse of any wagon or other public highway now located therein, nor prevent the location through the same of any such wagon road, or highway where such road, or highway may be necessary for the public accommodation; and where any change in the location of such wagon road is necessary to permit the passage of such railroad through any canyon, pass, or defile, said railroad company shall before entering upon the ground occupied by such wagon road, cause the same to be reconstructed at its own expense in the most favorable location, and in as perfect a manner as the original road;

provided, that such expenses shall be equitably divided between any number of railroad companies occupying and using the same canyon, pass, or defile.

445. Must Maintain Good Crossings.—Every railroad company shall be liable for damages caused by its neglect to make and maintain good and sufficient crossings at points where any line of travel crosses its road.

447. Ringing Bells and Blowing Whistles at Crossings.—Every locomotive shall be provided with a bell weighing not less than 20 pounds, which shall be rung continuously from a point not less than 80 rods from any street, road, or highway crossing, until such street, road, or highway shall be crossed, but the sounding of the locomotive whistle at least one-fourth of a mile before reaching any such crossing shall be deemed equivalent to ringing the bell as aforesaid, except in towns and at terminal points; during the prevalence of fogs, snow and dust storms, the locomotive whistle shall be sounded before each street crossing while passing through cities and towns. All locomotives, with or without trains, before crossing the main track at grade of any other railroad, must come to a full stop at a distance not exceeding 400 feet from the crossing, and must not proceed until the way is known to be clear; two blasts of the whistle shall be sounded at the moment of starting; provided, that whenever interlocking signal apparatus and derailing switches are adopted such stop shall not be required. Every person in charge of a locomotive, for any neglect to observe the provisions of this section, shall be deemed guilty of a misdemeanor, and the corporation shall be liable for all damages which any person may sustain by reason of such neglect.

VERMONT.

Section 3838. Crossing Highways and Turnpikes.—If, after laying out and constructing a railroad, a turnpike or other way is laid out as to cross a railroad, the turnpike or other way may pass over, under, or across the railroad, and shall be so built as not to obstruct or injure it, but in case the turnpike or other way is laid out to cross the railroad at grade the railroad commissioners, on application of the parties owning or operating the railroad, shall, upon notice and hearing, determine whether said crossing ought to be at grade, and if the commissioners determine that the crossing ought not to be at grade, it shall be constructed over or under the railroad.

Section 3840. A railroad may be so laid out as to cross a turnpike or other way, if the railroad commissioners shall judge it necessary, and the corporation may raise or lower the turnpike or other way, for the purpose of having its railroad pass over or under it, but said corporation shall restore the turnpike or way as far as practicable, and so as not to impair its usefulness.

Section 3842. The railroad commissioners may, when in their opinion the public safety requires an alteration of a highway crossed at grade by a railroad, after a hearing had upon such notice as they shall deem reasonable to the company owning or operating said railroad, and to the selectmen of the town or mayor of the city within which said highway is situated, and to the owner of land adjoining said crossing, order such alteration in such highway as they deem best, and shall determine and direct by whom such alterations shall be made, at whose expense, and in what time; provided, that such alterations as are made at the primary instance of the railroad commissioners shall not be ordered

at the rate of more than one a year in any one county on any one railroad. Railroad companies may take land for the purposes mentioned in this section, in the manner provided by law for the taking of land by railroad companies.

Section 3843. The railroad commissioners may apply to the supreme judicial court for the enforcement of said order; a notice of which application shall be given to the railroad company at least 12 days before hearing. The supreme court shall have equity powers in the premises, and may, upon hearing, revise or modify the order of the commissioners, and for that purpose may order the taking of testimony in such manner as it deems best.

Section 3844. When a railroad company has constructed a railroad across a public highway by passing upon, over or under the traveled path thereof, the corporation shall keep in good and sufficient repair, and rebuild, when necessary, bridges, culverts, crossings and other constructions made for the accommodation, safety and convenience of the public travel on the highway, over, under, or upon such railroad. And a railroad corporation so constructing a railroad across a highway, shall be liable to the town, within whose limits the crossings are, for damages occasioned to such town by reason of such corporations not complying with the provisions of this section; and such liability shall extend to expenses incurred by the town in connection with actions against it by reason of such non-compliance.

Section 3848. Signboards, Flagmen, Gates and Signals.—A railroad corporation shall maintain at every public highway or street where the same is crossed by its railroad at grade, warning boards of such description as the railroad commissioners approve. The warning boards or crossing signs in use on the first day of December, A. D. 1888, may be used while they remain legible and in good condition, and until it is necessary for the same to be renewed.

Section 3849. A bell of a least 30 pounds' weight shall be placed on each locomotive engine, and be rung at the distance of at least 80 rods from the place where the railroad crosses a road or street at grade, and be kept ringing until it has crossed such road or street; or the steam whistle may be blown instead of ringing said bell.

Section 3850. If a person or corporation owning or operating a railroad unreasonably neglects or refuses to comply with the provisions of the two preceding sections, it shall be fined not more than $1,000.

Section 3851. The railroad commissioners, when requested in writing by three or more freeholders of any city or village in the state, to order a gate or electric signal to be erected, or a flagman to be stationed at any railroad crossing at grade, within their respective cities or villages, shall visit such place, first giving the parties making such request and the railroad company notice thereof, and if the public safety requires, shall order the company operating said railroad to erect and maintain a gate or gates, or electric signal, or to keep a flagman, or to do any other act at said place needful for the protection of the public, and may specify when said gate or gates shall be opened and closed, or when a flagman shall be on duty, and may change any such order when they deem it necessary, first visiting the place and giving the railroad company and the parties making such request an opportunity to be heard thereon.

Section 3871. Farm Crossings, Cattle-Guards.—A person or corporation owning or operating a railroad shall construct and maintain farm crossings of the road for the use of the proprietors of lands adjoining the railroad, and cattle-guards at all farm and road crossings, sufficient to prevent cattle and animals from getting on the railroad.

Section 3872. If the parties cannot agree upon the plan, manner or number of the farm crossings, the same shall be determined by commissioners; but if the cost of such farm crossings exceeds the value of the land to be accommodated thereby, the commissioners need not order such crossings to be made, but shall award reasonable damages in lieu thereof.

Section 3873. The provisions of law relieving parties owning property adjoining a highway from maintaining fences along the line of such highway shall not be held to relieve persons owning or operating a railroad from maintaining cattle-guards at points where such railroad crosses a highway at grade.

VIRGINIA.

Section 1092. Company to Provide Wagon Ways.—It shall be the duty of every railroad or canal company, whose road or canal passes through the lands of any person in this state, to provide proper and suitable wagon-ways across said road or canal from one part of said land to the other, and keep such ways in good repair. Such ways shall be constructed on the request of the land-owner in writing, made to any section master or employe of the company having charge or supervision of the road or canal at that point, and shall designate the points at which the wagon-ways are desired. If the company fail or refuse for 10 days after such request to construct the wagon-ways of a convenient and proper character at the places designated, then the owner, having given 10 days' notice in writing to such section master or employe, may apply to the county court of such county for the appointment of three disinterested commissioners, whose lands do not abut on the railroad or canal, whose duty it shall be to go upon the land and determine whether the wagon-ways asked for should be constructed. Their decision shall be in writing, and if favorable to the land-owner, it shall set forth the points at which the wagon-ways should be constructed, giving also a description of what should be done by the company to make a suitable and convenient way. The decision shall be returned to and filed in the clerk's office of the county court of such county, and when called up at the next or any succeeding term of said court it shall be confirmed, unless good cause is shown against it by the company, either party to have the right to appeal from the judgment of the court to the circuit court. If the company shall fail for 20 days after the confirmation by the court of a report favorable to the land-owner to make the wagon-ways therein referred to of a suitable and proper character, then thereafter it shall pay the land-owner $5 for every day of such failure. The commissioners shall each receive for their services the sum of $1 per day, to be taxed as a part of the costs of the proceeding.

Section 1094. How Road or Canal May Be Crossed to Suit Another Road.—If any railroad, turnpike or canal company deem it necessary in the construction of its works to cross any other railroad, canal, turnpike or county road, it may do so; provided, such crossing shall be so located, constructed and operated as not to impair or impede in the least degree practicable the works and operations of the railroad, turnpike or canal to be crossed; and provided such crossing shall be supported by such permanent and proper structures and fixtures and shall be controlled by such customary and approved appliances, methods and regulations as will best secure the safe passage and transportation of persons and property along such crossing, and will not be injurious

to the works of the company to be crossed. The cost of such crossings, their appliances, apparatus and the repairs and operation of the same shall be borne by the party desiring to make the crossing. Before work is commenced upon the crossing, the president or general managing officer of the company which proposes to cross the works of another company, shall submit plans, specifications, appliances and methods of operation to the president or other general officer of the latter company, and if the said plans, specifications, et cetera, are not accepted within 30 days after the same have been delivered to the president or any general officer of the company whose works are to be crossed, the president or general managing officer of the first named company may then proceed with the construction and operation of the said crossing under the plans, specifications, appliances and methods so submitted; provided, however, the president or general managing officer of the company whose works are to be crossed, may, within 15 days from the date of such notice, apply to the board of public works to inquire into the necessity of such crossing and the propriety of the proposed location and all matters pertaining to its construction and operation; and thereupon, within 30 days from the date of the first notice aforesaid, the board of public works in its discretion may, by notice served upon both companies, suspend work on said crossing for such reasonable time prescribed in said notice as it may deem necessary to make such inquiry. The said board of public works may in their discretion employ expert engineers at a cost not exceeding $500, to be paid equally by both companies, who shall, with the railroad commissioner, examine the location, plans, specifications, appliances and methods proposed to be employed, and shall hear any objections and consider any modifications that the railroad, whose line is to be crossed, desires to offer, and within the time prescribed aforesaid shall make a report, rejecting, approving or modifying said plans and specifications, which shall be final and binding on both companies. If any such company desires that the course of any other railroad, turnpike or canal shall be changed to avoid the necessity of any crossing, or frequent crossings of the same, the change may be made in such manner and on such terms as may be agreed on by the company desiring the change and the company, persons or county owning or having charge of the work to be affected by the change. If any such crossing or change as is provided in this section cause damage to the work of any company or county or to the owner of any lands, the company exercising the privileges herein granted shall make proper compensation for such damage. Upon failure of the company desiring to make the crossing to receive notice of the acceptance of the said plans, specifications, et cetera, within 30 days from giving the notice as aforesaid, or upon the adoption of the plans and methods by the board of public works, and the payment of proper compensation for damages by the company desiring to cross the works of another company (damages to be ascertained according to sections 1074 to 1084, inclusive, Code of 1887), work may be commenced immediately, and no order shall be made or any injunction awarded by any court or judge to stay the proceedings or prosecution of the work; but any county road and stream or watercourse may be altered by any such company, for the purpose aforesaid, whenever it shall have made an equally convenient road or waterway in lieu thereof.

Section 1095. Railroads, County Roads, and Streets to Cross Each Other at Easy Grades.—Every railroad hereafter constructed across a county road, street, or other highway, and every county road street, or other highway hereafter constructed across a railroad,

shall, as far as practicable, pass at surface grade, or pass beneath or above any existing structure at a sufficient depression or elevation, as the case may be, with easy grades, so as to admit of safe and speedy travel over each.

Section 1096. Crossings; How and by Whom Made.—At every existing crossing such as is mentioned in the preceding section, the grade of the work last constructed, to the full width of the railroad land, shall be made sufficiently smooth and level to admit of safe and speedy travel over such crossing. Where such improvement is to be made in a railroad, it shall be made by the corporation, company, or person operating the same. Where it is to be made in a county road, street, or other highway, it shall be made by the authorities having the control of such county road, street, or other highway, and charged with the duty of keeping the same in order.

Section 1258. To Enclose Roadbeds with Fences; Cattle-guards.—Every such company shall cause to be erected along its line and on both sides of its roadbed lawful fences as defined in section 2038, which may be made of timber or wire, or both, and shall keep the same in proper repair, and with which the owners of adjoining lands may connect their fences at such places as they may deem proper. In erecting these fences the company shall at the termini of those portions of its roadbed which it is required to fence, and on each side of all public and private crossings, construct across its roadbed and keep in good repair sufficient cattle-guards with which its fences shall be connected. Such cattle-guards at private crossings may, with consent of the owners of said crossings, be dispensed with, the company in lieu of cattle-guards erecting and keeping in good order sufficient gates. But no court of this commonwealth shall have jurisdiction by writ of mandamus or otherwise to compel the erection of such fences, or building such cattle-guards.

Section 1262. Construction of Cattle-guards.—It shall be the duty of every railroad company whose road passes through any enclosed lands in this state to construct and keep in good order cattle-guards sufficient to prevent the passage of stock of every kind over such land at any point where a fence may be necessary or proper, whether it be a division fence between contiguous farms or between different parcels or tracts belonging to the same person, or a fence along a public highway. Such cattle-guards shall be constructed on request of the land-owner in writing, made to any section master or employe of the company having charge or supervision of the road at that point. If the company refuse or fail, for 10 days after such request, to construct the cattle-guard at the place designated, the owner, having given 10 days' notice in writing to such section master or employe, may apply to the county court of such county for the appointment of three disinterested freeholders, whose duty it shall be to go on the land and determine whether the proposed cattle-guard shall be constructed. Their decision shall be in writing, and shall be forthwith returned to and filed in the clerk's office of the county court of such county. If such decision be that the cattle-guard ought to be constructed, the company shall, within 20 days thereafter, construct the same. Upon its failure so to do, it shall pay the land-owner $5 for every day of such failure.

Section 1263. Their Discontinuance.—Every railroad company, after erecting the fences mentioned in section 1258, may discontinue all cattle-guards enclosed by such fences, except such as are provided for in sections 1258 and 1262, and in lieu thereof the owners of con-

tiguous lands may connect their fences with those of the company at such place or places as they may desire.

An Act Requiring the Use of Bells and Steam Whistles on Locomotive Engines Before Reaching Highway Crossings, to Protect Human Life.—1. Be it enacted by the General Assembly of Virginia, That a bell and a steam whistle shall be placed on each locomotive engine operated on any railway in this state, and said whistle shall be at least twice sharply sounded, not less than 300 yards before a highway crossing is reached; provided, that at street crossings within the limits of incorporated cities or towns the sounding of the whistle may be omitted, unless required by the council of any such city or town, and the company shall also be liable for all damages which shall be sustained by any person by reason of such neglect.

WASHINGTON.

Corporations may change the grade or location of their road, not departing from the general route specified in the articles of incorporation, for the purpose of avoiding annoyances to public travel, or dangerous or deficient curves or grades, or unsafe or unsubstantial grounds or foundations, or for other like reasonable causes, and for the accomplishment of such change shall have the same right to enter upon, examine, survey, and appropriate the necessary lands and materials as in the original location and construction of such road.

When it shall be necessary or convenient in the location of any road to appropriate any part of any public road, street, or alley, or public grounds, the county court of the county wherein such road, street, alley, or public grounds may be, unless the same be within the corporate limits of a municipal corporation, is authorized to agree with the corporation constructing the road, upon the extent, terms, and conditions upon which the same may be appropriated or used and occupied by such corporation. If such parties shall be unable to agree thereon, such corporation may appropriate so much thereof as may be necessary and convenient in the location and construction of said road.

There are no general statutes in this state regarding the placing of signboards, the erection of cattle-guards, or the stationing of flagmen at crossings.

WEST VIRGINIA.

Railroad companies are required to erect signboards at points where their tracks cross a public highway on the same level. The boards must be elevated so as not to obstruct travel, and be easily seen by travelers; on each side of the boards is to be painted in legible capital letters the words, "Railroad Crossing—Look Out for the Locomotive."

Railroad companies are required to construct and maintain suitable farm crossings, cattle-guards and fences on both sides of land that has been cleared and fenced through which the road has been constructed.

A bell or steam whistle must be placed on each locomotive engine, and must be sounded at least sixty rods from the place where said railroad crosses a public highway. Where two railroads cross each other on the same level, a flagman is required to be stationed at such point at the joint expense of the roads so crossing each other at a common grade.

WISCONSIN.

Section 1809. Every railroad corporation shall put up and maintain at all times, at every place where their railroad track crosses a public highway, and near such crossing, a large signboard with the following inscription, painted in large letters on each side: "LOOK OUT FOR THE CARS," in such manner as to be visible on the highway track at least 100 feet distant on each side of the crossing; and before crossing any highway, except in cities and villages, with any locomotive, the whistle shall be blown 80 rods from such crossing, and the engine bell rung continuously from thence until the highway be crossed by the locomotive. In all cities and villages the engine bell shall be rung before and while crossing any street, and no train or locomotive shall go faster, until after having passed all the traveled streets thereof, than at the rate of 6 miles per hour.

Section 1810. Every railroad corporation operating any railroad shall erect and maintain on both sides of any portion of its road (depot grounds excepted) good and sufficient fences of the height of 4½ feet, with openings, or gates, or bars therein, and suitable and convenient farm crossings of the road for the use of the occupants of the lands adjoining, and shall construct and maintain cattle-guards at all highway crossings, and connect their fences therewith, to prevent cattle and other animals from going on such railroad. All roads hereafter built shall be so fenced and such cattle-guards be made within 3 months from the time of commencing to operate the same, so far as operated. Until such fences and cattle-guards shall be duly made, every railroad corporation owning or operating any such road, shall be liable for all damages done to cattle, horses, or other domestic animals, or persons thereon, occasioned in any manner, in whole or in part, by the want of such fences or cattle-guards. But after such fences and cattle-guards shall have been in good faith constructed, such liability shall not extend to damages occasioned in part by contributory negligence, nor to defects existing without negligence on the part of the corporation or its agents. A barbed wire fence, consisting of not less than 5 barbed wires, with at least 40 barbs to the rod, firmly fastened to posts, well set, not more than 16½ feet apart, with one good stay between, the top wire not less than 48 inches high and the bottom wire not more than 8 inches from the ground, and the spaces between the bottom and second, and second and third wires from the ground, not more than 8 inches each, shall be deemed a good and sufficient fence, and no fence shall be required in places where the proximity of ponds, lakes, watercourses, ditches, hills, embankments or other sufficient protection renders a fence unnecessary to protect cattle from straying upon the right-of-way or track.

Section 1811. When such fences and cattle-guards shall have been duly made and maintained, any person who shall wilfully take down, open or remove any such fence, cattle-guard or crossing, or any portion thereof, or allow the same to be taken down, opened or removed, or who, having lawfully taken down bars or opened gates in such fences for the purpose of passing through the same, shall not immediately replace or close the same, shall forfeit not less than $10 nor more than $50, and in addition be liable to the party injured for all damages resulting from such act or omission; and if any person shall ride, lead or drive any horse or other animal upon such road when such road be fenced, or if any person or persons shall ride, lead or drive any horse or horses or team or teams lengthwise of said track when it is not fenced (other than at the farm crossings, or upon depot grounds, or where the

same is laid along or across a public road or street), without the consent of the corporation or party having control of such road, he shall for every such offense, forfeit a sum not exceeding $10, to be recovered by such corporation or party in an action before any justice of the peace of the county wherein such offense is committed, and shall also pay all damages which shall be sustained by the company or party aggrieved. It shall not be lawful for any person, other than those connected with or employed upon the railroad, to walk along the track or tracks of any railroad, except when the same shall be laid along public roads or streets; provided, this section shall not be construed to prevent any person from driving across any such roads from one part of his own land to another.

Section 1828. Every corporation formed under this chapter shall have power:

5. Subject to the provisions of section 1836, to construct its railroad across, along, or upon any stream of water, watercourse, street, highway, plank road, turnpike or canal, which its route shall intersect or touch; to carry any highway, street, turnpike or plank road which it shall touch, intersect or cross, over or under its track, as may be most expedient for the public good; to change the course and direction of any highway, street, turnpike or plank road, when made necessary or desirable to secure more easy ascent or descent by reason of any embankment or cut made in the construction of the railroad, and take land necessary therefor; provided, such highway or road be not so changed from its original course more than 6 rods, nor its distance thereby lengthened more than 5 rods.

Section 1836. Every corporation constructing, owning or using a railroad, shall restore every stream of water, watercourse, street, highway, plank road, turnpike, or canal across, along or upon which such railroad may be constructed, to its former state, or to such condition as that its usefulness shall not be materially impaired, and thereafter maintain the same in such condition against any effects in any manner produced by such railroad. When any lands shall be required in order to change any highway, street, turnpike, or plank road, the same may be condemned, taken, and compensation made in the manner provided in this chapter; and when so taken, shall become a part of such highway, street, turnpike or plank road to the same extent as, and by the same tenure by which, the adjacent parts thereof are held.

Section 1836a. It shall be the duty of every corporation owning or operating any railroad in this state, to keep their right-of-way clear of locust, brush or other kinds of brush or trees growing on the same, the distance of 20 rods each way on their right-of-way at the intersection of any public highway by such railway in this state; provided, however, that in timbered sections of country and the lands adjacent to such crossing of public highways by railways and not occupied and cleared, the said corporation shall not be liable under the provisions of this Act, till the said adjacent lands be occupied or cleared, then this Act to apply as stated herein. On the neglect or refusal of such railway corporation to comply with the provisions of this Act, the town board of supervisors, by its chairman in the towns through which such railway corporations have right-of-way, shall make complaint and cause an action to be brought against such corporations in any justice court or municipal court in any county where such action may be necessary according to the provisions of this Act. The penalty for neglect or refusal shall be $100, one-half to be paid to said town prosecuting the same. And provided further, that any

person owning any land adjacent to such highway and railway the distance of 20 rods from such railway intersection of highway, shall, in like manner, clear such land from brush and trim up to the height of 10 feet from ground [any] trees thereon they may desire to leave for shade trees, and for neglect or refusal to comply with the provisions of this Act an action to be commenced and prosecuted as above provided and the penalty therefor enforced.

Section 1836b. Whenever any highway heretofore or hereafter to be laid out shall cross any railroad and the supervisors of the town, trustees of the village or county board of supervisors, in case of a county road, in which said road shall lie, shall deem it to the best interest of the public that said highway should be so constructed as to cross said railroad above or below the tracks of said railroad, and an amicable arrangement can be made between said town or county supervisors or village trustees and the owner or operator of said railroad as to the manner of said crossing and for the doing of such work and the construction of such piers, abutment, bridge, truss or other device for such crossing by said highway over or under its tracks, said town or county supervisors or village trustees, as the case may be, may enter into a contract with said railroad owners or operators for the doing of such work and such construction; and said town or county supervisors or village trustees shall after the execution of said contract assess upon the taxable property of said town, village or county, as the case may be, at the time other highway taxes are therein assessed, a tax sufficient to raise the amount necessary to carry out said contract, and the same shall be collected when other taxes are collected, and shall be set aside as a special fund, and the same shall be paid for said work in installments as such work progresses or otherwise, as may be provided for, in and by said contract, upon town, village or county orders, as the case may be.

Section 1837. When it shall be necessary, in the construction of a railroad, to erect a bridge or arched culvert over any highway, street, turnpike or plank road, it shall be sufficient to construct the same so as to give a clear passage-way of 20 feet, or two passage-ways of 14 feet each. All bridges now or hereafter constructed across the Fox or Wisconsin river shall be constructed or modified, and such reasonable alterations therein made, from time to time, as may be required, and according to plans approved by the Secretary of War of the United States, or such engineer as he shall designate, by any railroad corporation owning or using the same.

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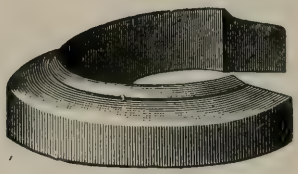

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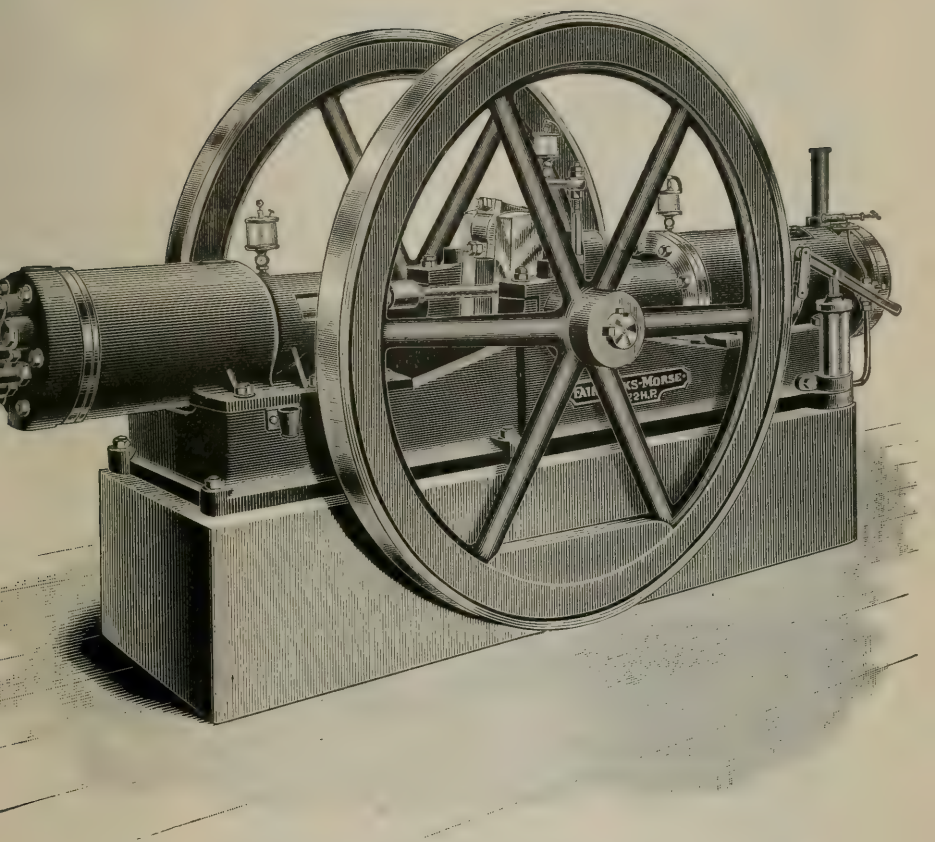

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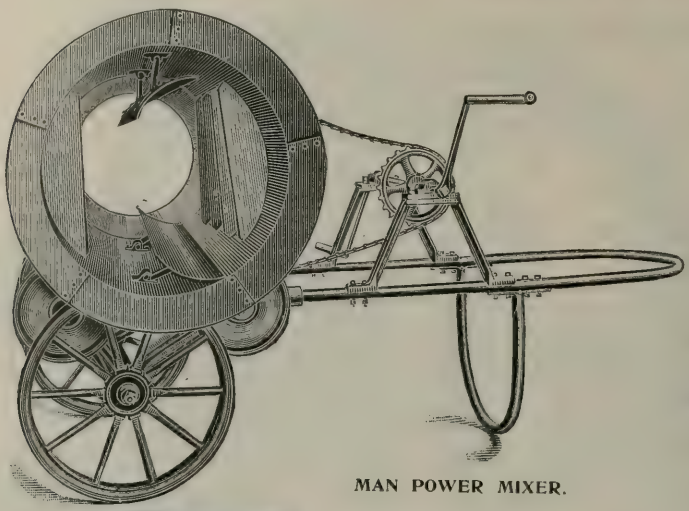

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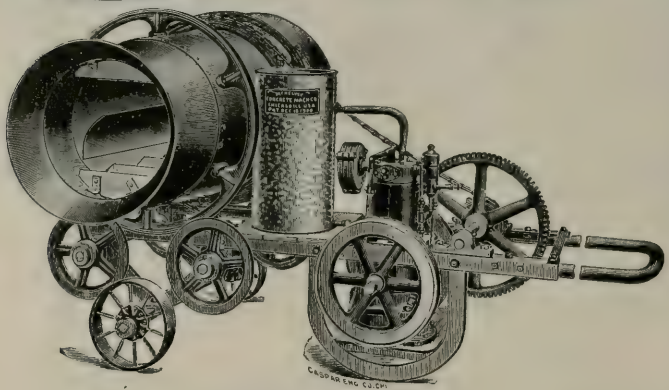
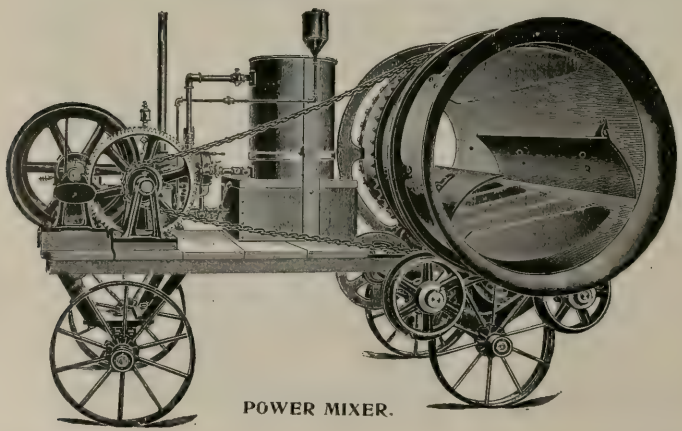


PUSH CART POWER MIXER.



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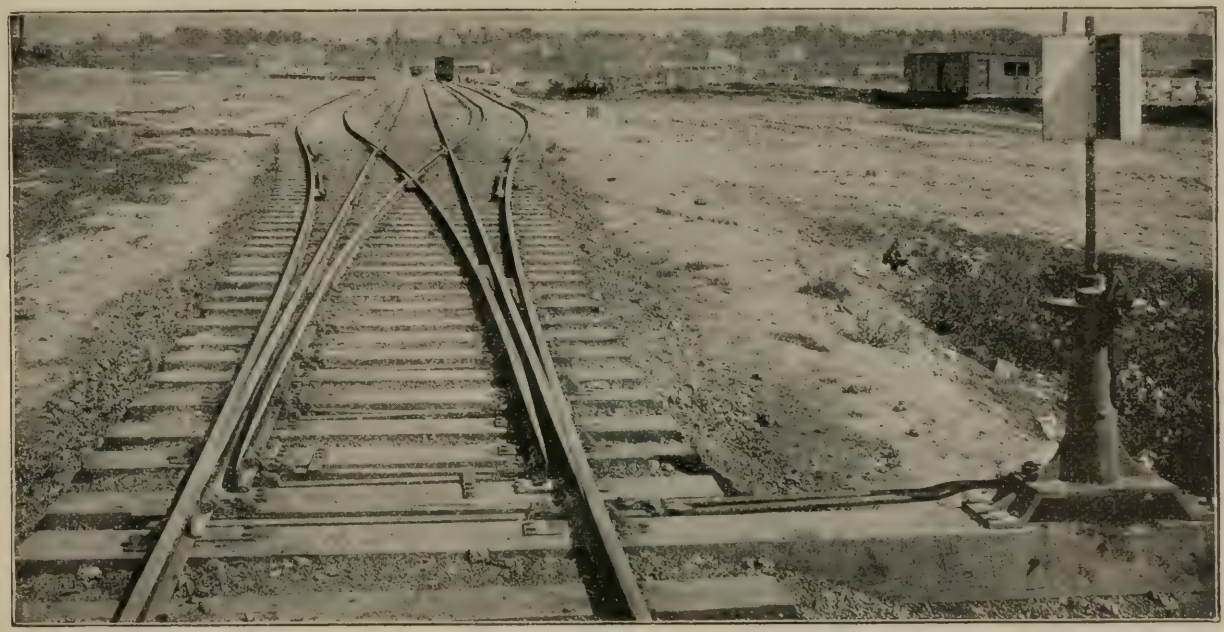
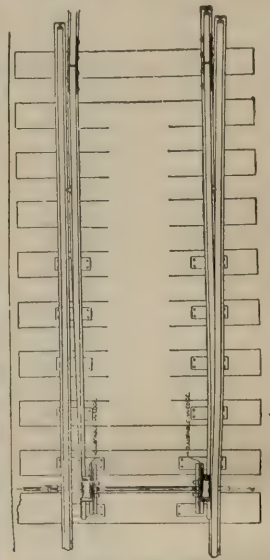


THREE THROW SPLIT SWITCH



ADJUSTABLE SPLIT
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ADJUSTMENT

WROUGHT IRON
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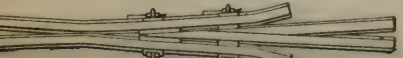
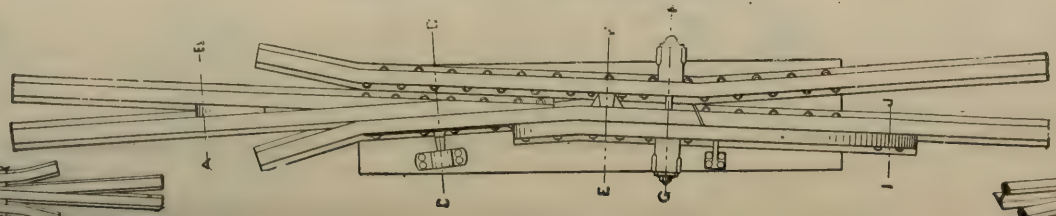
AUTOMATIC PARALLEL GROUND THROW





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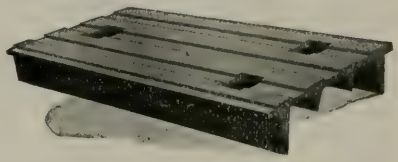
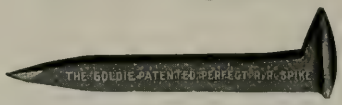
The most efficient rail brace on the market. Holding the rail absolutely to gauge.

The Glendon Flange Tie Plate.



The strongest flange plate manufactured. Especially adapted for use in soft wood ties.

The Goldie Patent Perfect R. R. Spike.



This spike has from 40% to 100% greater adhesion than the common wedge point spike. This spike absolutely necessary for soft wood ties.

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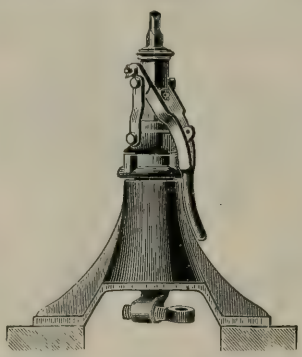

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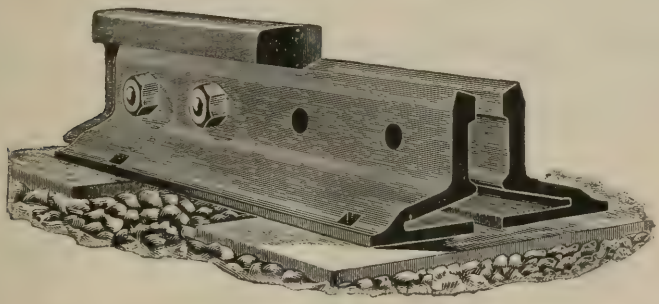

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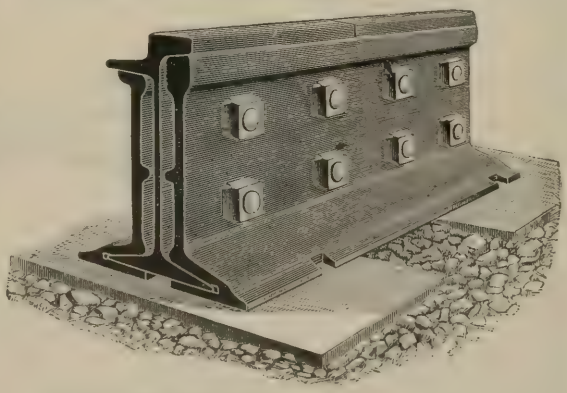

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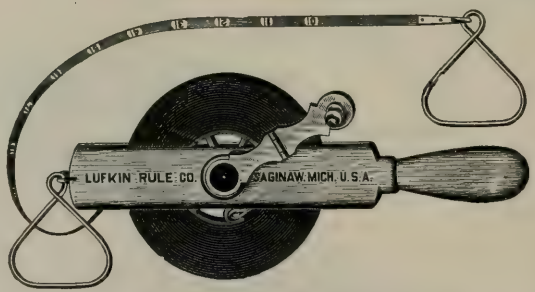

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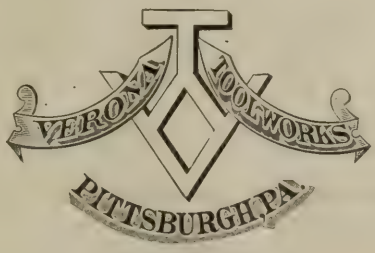

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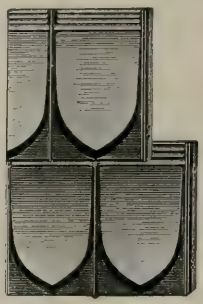

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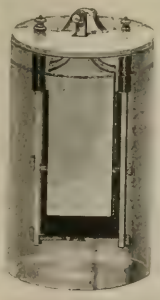

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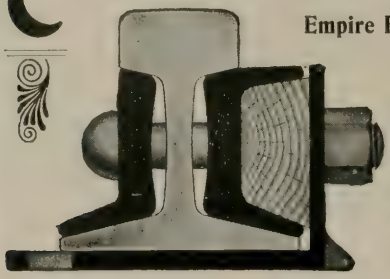

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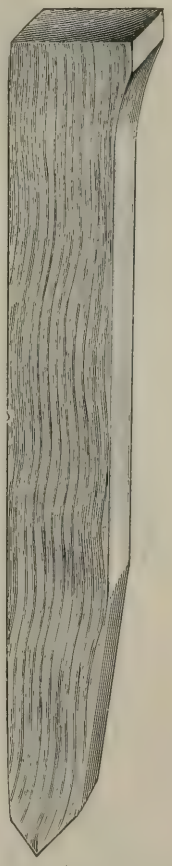

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